

Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

PUBLISHED BY MCGRAW PUBLISHING COMPANY, INC.

Volume 71

NEW YORK, SATURDAY, JANUARY 30, 1915

Number 5

War and Water

WITH large areas in England converted into army instruction camps it is natural to assume that waterworks men are assuming greater responsibility in preventing the pollution of supplies. Where the wastes of thousands, in an encampment, must be disposed of daily, every precaution known to sanitary science must be taken to prevent the spread of disease. If the camp site be located on a watershed, the problem is further complicated, for then it is necessary to maintain rigid standards not only among the soldiers but also among the inhabitants of the city dependent upon the supply. In former days such a condition might have been followed by serious consequences, but with the methods now available for the purification of water, including filtration and emergency sterilization with hypochlorite, there is little to be feared if intelligent supervision is exercised.

Manual of Timber Treatment

ALCHEMY has no part in the preservation of timber. There is nothing mysterious or supernatural about a treatment plant or the manufacture of the preservative. It was, therefore, gratifying to hear one member of the industry at the meeting of the American Wood Preservers' Association last week state that the time was fast approaching when the same inspection facilities would be afforded to purchasers of creosoted products as those demanded by and given to buyers of steel and cement. Furthermore, there is needed a wider knowledge as to the various preservatives and the treatment requirements for different purposes. Just what result may be expected from each chemical and grade of chemical under a given service must be learned, so that a correct valuation can be placed on each under the various conditions. Considerable information of the kind is now available in the proceedings of the society and in the bulletins of the Forest Products Laboratory. The purchaser, however, does not always have the facts at hand, and the association has a tremendous task ahead of it in getting this information in usable form into the hands of engineers, architects and other wood users. Technical schools are able to give the subject little attention. To meet the need the compilation of a manual of recommended practice has been determined upon. It is a wise move, and engineers and purchasers generally will be grateful for early publication.

Safeguards for Contractor's Plant

IN another part of this issue is a description, by the president of a large mining company, of the way in which it has safeguarded its steam shovels until they are

almost fool proof. This is a matter which contractors can well consider, not only on steam shovels, but on all construction equipment. The toll which preventable accidents take of a contractor's force is serious, apart from the liability expense involved. Any one, even the oldest and most experienced construction man, is liable to accident from machinery that is not properly enclosed. One would scarcely think of the gears between a vertical engine and a concrete mixer as a source of danger. About a year ago, however, a capable and experienced master mechanic on a large job was caught in them and seriously injured. The sudden loss of such a man's services is felt in a money way by his employer. Looking at the matter in another light, safety guards on machinery increase the output of the crew working on the machine. The men do not have to be constantly on the alert to protect themselves from a menace which should not exist. They are able to devote their whole attention to their duties, and to give better service. Such improvements heretofore have been undertaken by contractors generally through legal compulsion. Now, however, more of them are coming to see the advantage and even the necessity of these safeguards. Such things as unguarded moving machines, dangerous derrick rigging, and high, narrow runways without handrails can and should be eliminated for the benefit of both workmen and contractor.

The Canal's "Mechanical Mules"

TO the man whose conception of towing reverts to boyhood memories of the "swimmin' hole" at the canal, and weary mules plodding along a dusty tow-path, with a sluggish barge in their wake, the story on page 134, telling how huge battleships and ocean liners are convoyed through the locks at Panama by powerful electric locomotives, will be a startling disillusionment. The familiar scene of the bargeman hurling profanity and lumps of coal at his four-legged propellers changes to one of silent mechanical action, orderly systems of tracks, electric control, and a trained corps of operators. Accidents at the Soo Canals and elsewhere, caused by unmanageable ships colliding with the lock gates, have demonstrated the importance of having vessels under complete control while passing from one level to another. When it was decided to reject the sea-level project at Panama this phase of canal operation received a good deal of study, and there was evolved a plan whereby vessels would be towed through the locks by electric locomotives instead of steaming through under their own power. The towing locomotives are the first of their kind and as the successful operation of the canal depends upon

their ability to do the work for which they were designed, the account of their construction and operation adds a new chapter to the history of canal engineering.

Appealing to the South American

SOUTH American opportunities have been the cause of a rapid multiplication of catalogs printed in Spanish by American manufacturers. One of these, recently received, points out the dangers that other manufacturers need to avoid. While it represents a large expenditure and is above criticism typographically, it contains grammatical blunders and some expressions that are far from conveying the proper intent. Such errors, of course, would seem easy of avoidance, for any finished Spanish scholar could have detected them. They are certain to lessen the influence of the catalog on those for whom it is intended. But mere grammatical correctness is not sufficient if trade literature is to be most effective. From the American business man's point of view a literal translation of an American catalog should answer the purpose. This is far from being true. It is necessary that the publication breathe the spirit of those whom it is to influence, as well as speak their language. Advertising is an exercise in appeal, it is psychology in practice, and evidently the appeal will fail if the form repels. Spanish and Portuguese catalog making, therefore, must not be entrusted to a translation bureau, capable enough in turning into English business letters from South America, but lacking in that knowledge of South American temperament and business methods which the merchant may neglect only at the peril of his commercial success. Such work must be done by those familiar with the people they are addressing, and some experienced exporters declare that it is done satisfactorily only in South America itself. For that reason they have their catalogs translated there. What has been said of catalogs is true of letters, and those having much prospective business with South American countries would be well advised to retain for their translations someone thoroughly familiar with South American conditions.

A Call to Duty

ENGINEERS have for years talked about participation in public affairs, but never before has their plain duty to the State been more forcefully presented than in the article by William R. King, printed on page 133 of this issue. Heretofore appeals have been for the exercise of influence and the playing of a part in civic affairs. Now the call is to the country's defense. Those who have followed the editorials in the

Engineering Record since the beginning of the European war appreciate keenly what an important part the engineer is playing in that conflict. With them Mr. King's argument will have special weight. This matter has already been placed before men high in both civic and military life and has received their endorsement. The Chief of Engineers, General Kingman, approves it heartily, while the Acting Chief of Staff of the U. S. Army urges that the matter be pushed and offers the co-operation of an army officer in working out the details. Looking back with "efficient hind sight," our indifference to national defense has been appalling. To cite an example that will appeal to every engineer, it is only necessary to point out that hundreds of young engineers are being graduated annually from the Land-Grant colleges, in which every student takes military drill for two years. These young engineers would be most valuable officer recruits in time of emergency, yet no attempt has been made on the part of the War Department to keep in touch with them after graduation, and to advise them as to changes in equipment and drill regulations. Keeping in touch with them is an obvious step, but broader plans, involving military instruction in technical schools, are needed. That Great Britain is now appreciating the value of engineers as officers is evident from a circular of the Institution of Civil Engineers urging its members to take out commissions. At the present time the American Institute of Consulting Engineers and the secretary of the American Society of Mechanical Engineers are taking an interest in this matter, and, knowing their vigor, there is every reason to believe that something will come of their efforts.

Telephoning Across the Continent

BY the achievement of ocean-to-ocean telephony on January 25, applied electrical science made another wonderful stride forward and in a new sense completed the conquest of the American continent. The transmission of speech from the Atlantic to the Pacific appeals to the imagination of engineer and layman alike. Whoever has made the fascinating journey across this favored land must picture to himself the varied climatic and scenic conditions traversed in this new flight of electricity and it needs no extended words to hint to such a one the vast succession of plains, rivers, valleys and mountain ranges which have become as nothing before the mind and hand of the telephone expert.

The painstaking steps which have led to this final triumph need not be detailed here, but anyone with the most superficial knowledge of telephony must realize that it is the result of long and arduous research, of costly experiments in line construction, of profound studies in central office and substation equipment, and of fatigue and discomforts sustained by many men in cold weather and warm.

It is hardly to be expected that transcontinental telephony will become a popular diversion at a cost of something like \$20 for

a 3-min. conversation between New York and San Francisco, but the amount of plant at the disposal of the subscribers, involving approximately 3000 tons of copper wire and 130,000 poles in addition to the transmitting and receiving apparatus, switchboard auxiliaries, etc., explains to some extent the cost of an exclusive temporary right of way across the United States. Probably the greatest gain will be to users of intermediate toll service, and the linking of Chicago, Denver and other cities with the Pacific Coast will do much to expedite important business by telephone and tie together great areas until very recently on the frontiers of this form of communication. It was a happy circumstance that Dr. Alexander Graham Bell and Thomas A. Watson, participants in the first telephone conversation in the world some thirty-eight years ago, exchanged greetings on Jan. 25 over the new lines, and the inauguration of commercial service set for March 1 could not have been preceded by a more suitable preliminary test.

The War and Engineering Contracts

SOME curious situations have arisen in construction work as a direct consequence of the complete upsetting of the industrial situation by the war. Prior to its outbreak many contracts had been made for engineering material and work with firms among the several warring nations. In some cases subcontracts let in the ordinary course of business have turned out to be in directly hostile hands, or, if not this, still with countries whose industries have been virtually crippled by hostilities. Of course the warring nations are the greatest direct sufferers in this situation, but neutrals, including ourselves, are in many minor ways crippled. Under these circumstances it is a serious question of right and wrong as to what steps are to be taken with respect to insuring the completion of work undertaken, with justice to all parties concerned.

One need not be immediately concerned with such strenuous circumstances as contracts laid in the immediate scene of hostilities. In such cases the impossibility of performing the requirements is obvious, and while it comes pretty near to blasphemy to call the present war an act of God, it is from any standpoint a valid excuse for the non-performance of the impossible. Were there any prospect of immediate settlement of the struggle there might be many cases in which the architect or engineer having supervision of the execution of the contract could suspend its immediate performance and wait for things to clear up. Still other contracts are unfulfillable on account of dealing with contraband material, and would unquestionably be so held if it came to an issue.

There would seem to be no doubt as to the equities of the case, where a satisfactory substitute can be furnished, with such adjustment of the terms of the contract as may become necessary, and this should be the procedure where it is at all possible. If machinery ordered in Germany by an

American contractor working in South America cannot be delivered, the only thing to do is to abandon Germany as a source of supply on account of the inability of the subcontractor to ship his goods, and to order elsewhere a suitable substitute without imposing delays due to fruitless efforts to obtain shipments from the original source. Or if a German firm had ordered machinery in this country which could only be gotten through by a happy chance, it is certainly good morals for the purchaser to turn to the most available source of supply. The result of all this is going to be a considerable shift in the exact terms of many an undertaking, and there is reason to believe that the foreign trade of this country will be on the whole a gainer rather than a loser. If American salesmanship is suitably alert, a great many contracts will be picked up for goods to take the place of those put out of practicable delivery by the war. If the truth were known, it would probably be found that divers American goods have lost their market in serious amounts from the same cause, but that is one of the misfortunes which this and every other country must endure as part of the general calamity brought about by the hostilities.

American Society's Committee Work Shows Great Vigor

PROBABLY the outstanding feature of last week's meeting of the American Society of Civil Engineers was the evidence afforded of the greater virility of the work of the special committees. Some of the older ones have a record of which they may well be proud, though the nature of their assignments has been such that but little work has been done recently. Other committees, however, have slumbered peacefully year after year, awakening only to give a verbal or one-page-letter report at the annual meeting. The committees on stresses in railway track, on bearing power of soils, on compensation of engineers and on steel columns and struts are to be particularly commended. The committee on valuation reported only briefly, but the preliminary report made last year and the fact that two three-day sessions have been held since the vacancies caused by deaths were filled give assurance that this committee is fully abreast of the others in activity.

The greater virility is attributable to a number of causes—the temperament of the members appointed to the committees, the importance of the problems, the very certain though not loudly expressed demand by the membership at large for results worthy of the dignity of the society, and the appropriation of reasonable funds for the prosecution of committee work. The last is undoubtedly an important factor, for it enables the research work to be prosecuted without burdening the members of the committee financially. They already contribute all that can be expected—a liberal amount of time.

It is apparent, too, that the board of direction is determined that the vigor of committee work shall still further be in-

creased, for it has adopted and promulgated a set of rules for the government of committee activities. These rules in large part are expressive of common and expected practice, but two are especially worthy of note—that members who are not active may be removed, and that an abstract of the minutes of committee meetings shall be published in the "Proceedings." Presumably the board always had the power to relieve and replace a member, but this embodiment of authority in a rule carries with it unmistakably the intention of exercising the power. It is violating no confidence to say that it was put in as a fair warning that those who accept committee appointments will have to "fish or cut bait," or give some one else the opportunity.

The determination to publish monthly information regarding committee meetings is, also, a step in the right direction. The membership has a right to know what its committees are doing, and will undoubtedly respond with suggestions and offers of co-operation. This is but a first step and must shortly be followed by further news, put in readable and not in dry-as-dust minute form, of what the committees are doing.

The society has reason to be gratified at the condition and present spirit of this work.

More Light on the Compensation of Engineers

PROGRESS has been made in the study of the compensation of engineers in the second report of the committee of the American Society of Civil Engineers, presented in abstract, but with all diagrams, on page 139. The conclusion is unescapable, however, that we have not yet arrived at the truth, that there is still work for the committee. In saying this there is not lacking appreciation of that body's work and of its determination to gather further information. It now proposes to go outside the ranks of the society, to ask railroad and other large employers of civil engineers as to the salaries they pay, and to secure the use of data collected by technical colleges as to the earnings of their former students. It is possible, too, that the committee, for purposes of comparison, will look into the compensation of the legal and medical professions.

Two general conclusions seem to this journal to be of special importance: First, that the irregularity of the curves indicates an insufficient number of returns, and, second, that the rank and file are not truly represented, principally because these men do not join the society, but also because they are unwilling to make returns of compensation of which they are not proud. Certainly it will not be contended that the average curve, beyond the seventeenth year of experience, is trustworthy. The sudden rises and drops are not consistent with what we know to be the course of an engineer's progress and can only result from having abnormal groups. If the number of returns were larger—four or five times what they now are—this unevenness would

be ironed out. The curve for the middle man we believe to be more trustworthy, extending as it does without erratic movement until the twenty-fourth year of experience.

As evidence, however, that even this curve is too high one needs only to recall the compensation of railroad engineers and of those in municipal service. One's personal view of average compensations is likely to be influenced largely by that of the men with whom he chiefly associates, but if one will put the question squarely as to the salary at which he could secure men to fill satisfactorily given engineering positions requiring respectively five, ten, fifteen and twenty years' experience, a close approach to average compensation will be secured. In examining several hundred applications recently for a position requiring eight or ten years' experience and setting up high standards as to personality and general education it was found that the salary expected averaged about \$165 per month. This is below the middle man for eight years' experience in the committee's curve, even though the requirements were exceptionally high.

In the judgment of this journal the committee will come nearer the truth if data can be secured from large employers of engineers, for then those in the lower ranks of the profession are sure to be reported. These returns will include many who are not members of the society, for as pointed out by this journal in discussing last year's report only 18 per cent of 458 men, clearly listed in the "Pocket List of Railroad Officials" as doing engineering work, are members of the society. All of these 458, too, have some standing on their roads, and many able designers and constructors are undoubtedly not listed in this directory.

The committee states that it has been suggested that all incomes above \$15,000 be disregarded, but that it believes that the exceptional men must be included if a true picture of conditions is to be presented. There is, however, another point of view, that as technical men run, a truer prospect would be afforded the young engineer, and even him advanced in practice, if a new curve were plotted, arbitrarily scaling down all incomes above \$15,000 to that figure and basing the averages thereon. The resulting curve might closely approximate that of the middle man, but if so it would be worth while knowing. Another view of this suggestion is that on present standards about \$15,000 is considered sufficient to secure the services of engineers for even the largest enterprises. Witness the salaries of the chief engineers in charge of the Panama Canal, the Catskill Aqueduct and the New York subways (the incumbent of the latter place receives \$20,000). For sake of argument it might be assumed that the compensations above \$15,000 are due to very exceptional conditions. Certainly the averages presented are deceptive to those likely to take the standards for their own achievement from the committee's curves.

The diagram showing averages for different classes of service confirms in a general way what is already known—that governmental and teaching positions are less re-

munerative than those with corporations, and that consulting engineers and contractors top the list. While outside the scope of the committee's inquiry, it is pertinent to raise question as to the weight which should be given by an employee to permanence of position. Governments and universities are more steady as employers than private corporations, and in general railroad work has fluctuated less than that of other private enterprises. Certainly some sacrifice in salary is justified for steadiness of position. How great it should be is dependent on the individual's temperament and ability, but this factor should not be forgotten in appraising the desirability of teaching and governmental service as a lifework.

The curves showing earnings of members grouped geographically suggest some relation to the volume of engineering work. In the South, where engineering work is small in volume, compensation is lowest. The Middle Atlantic and Central States, where the volume is largest, overtop the New England and the Western States. The Middle Atlantic and Central sections, of course, contain most of the large cities, and the great work necessarily centering there has an undoubted influence. The higher compensation shown for men engaged in foreign work bears out what is generally known, but here again the hardships that must be endured, the risks to be taken and the separation from home must be weighed against the higher financial return. There is often, too, a decidedly speculative element in connection with the more important foreign engagements.

As to the curve of compensation for graduates and non-graduates, there is much opportunity for speculation. Speculation only, it would seem, is permissible, for the non-graduate class may include many who have had two or three years in technical colleges, giving them the scientific groundwork—by far the most important part—of the engineering course. Had there been four divisions—graduates, those with more than two years of collegiate work, those with two years or less, and those without any college work—the curves would have been far more illuminating. One pertinent question is suggested, but is not possible of fair discussion because of the deficiency mentioned. Whether, in view of the close approach of the two curves, the technical colleges are performing their duty satisfactorily. Theoretically one expects the graduate to have a tremendous advantage over the man who has not attended college. These curves indicate that there is not a great advantage over non-graduates—but then the question arises as to how many of those listed as non-graduates are entirely without college training.

The committee has done an interesting work. Its curves are not conclusive, not through any fault of the committee, but rather through the restriction of its work to the society's membership. A broadening of the inquiry will help much, while a comparison with the compensation of other professions may serve, and this journal believes will serve, to set at rest the claim that engineers are grossly underpaid.

New Methods of Pneumatic Tunneling Aid Safe and Rapid Completion of Passaic Valley Sewer Contract

Departure from Usual Heading Practice, and Use of Light, Pressed Steel Lining Plates, Expedite Driving of 12-Foot Concrete-Lined Bore Under Newark Streets

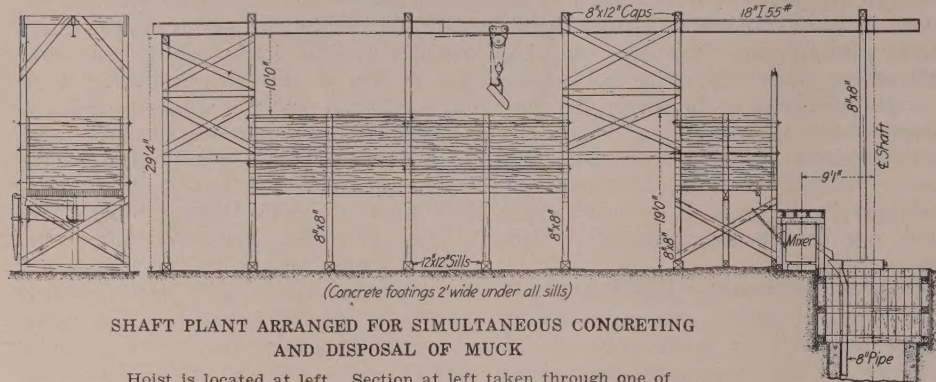
SEGMENTAL tunnel-lining rings of light, pressed steel plates, each section weighing only 20 lb., are believed to have been responsible in large measure for increased progress and safety in driving by compressed air methods through fine sand from 20 to 30 ft. below ground-water level the 12-ft., concrete-lined bore of a section of

but the actual outside diameter constructed was 3 ft. greater to allow for the use of clay in "mudding up," and to insure the specified thickness at all points where the center of the bore excavated might vary from the center of the tunnel.

The difficulties to be considered in planning the work included the sustaining of a

north of Sta. 83 (counting from Berlin Street and Hamburg Place) beneath a large water main carrying 150 lb. pressure, and only 10 to 14 ft. above the tunnel roof. Beneath the other loads the roof of the sewer was from 30 to 35 ft. below the street surface. For three-fourths the length of the contract, the streets are filled with a network of water and gas mains and electric conduits, and carry a double track trolley system.

The shield method of driving in this size of tunnel would have resulted in the loss of $\frac{3}{4}$ cu. yd. of ground not replaced per linear foot of tunnel, which would have caused the most serious damage. Moreover, it is very difficult to hold a shield to grade in the class of ground encountered. The method of tunneling used, however, overcame all these difficulties, replaced practically all the material taken out, and has sustained all the loads over the tunnel so far without serious enough settlement to cause any damage.



SHAFT PLANT ARRANGED FOR SIMULTANEOUS CONCRETING AND DISPOSAL OF MUCK

Hoist is located at left. Section at left taken through one of four hoppers to load wagons.

COMPRESSOR PLANT

the Passaic Valley sewer under Newark, N. J. Another feature was the needle-beam heading method, developed on work for the Metropolitan Sewerage Commission of Boston.

The work described in this article is covered by one of the three larger contracts for the main intercepting sewer which is being built to relieve conditions caused by the discharge of sewage into the Passaic River. About eighteen towns, with the city of Newark, have undertaken, jointly, the construction of this sewer, which will extend into lower New York Bay.

The portion of the Passaic sewer extending under Newark is mostly in fine sand, only $8\frac{1}{2}$ per cent of the excavation being in rock. The rock is a red sandstone and the soil, which varies greatly in composition, is water-bearing, requiring the use of compressed air in tunneling. This contract originally extended from Berlin Street and Hamburg Place to Clark and Ogden Streets, a distance of about 13,700 ft. Two adjoining contracts, however, were added to it, extending it on the lower end to 300 ft. west of Avenue L on Hamburg Place, and on the upper end to Third Avenue and the Erie Railroad, making a total length of 15,900 ft.

SHAFTS SUNK AS CAISSONS

Seven shafts were planned in the completed work, all of which were made 8 ft. in diameter to permit their being used for construction shafts. The contractor, however, elected to drive the tunnel from shafts 1, 3, 5 and 6 and to put in shafts 2, 4 and 7 after completing the tunnel beneath them. The plan of work called for sinking the four shafts as caissons, and driving a heading in each direction from each shaft. The sewer varies in inside diameter from 11 ft. 3 in. at the upper end to 11 ft. 9 in. in the central section, and 12 ft. 9 in. in the lower section. The contract outside diameter is 2 ft. 6 in. greater than the inside diameter,

number of loads where direct shoring was out of the question. The sewer was located as far as possible under the street; but in the case of Ballentine's brewery, where a new street is to be opened, the sewer went beneath the footings of a heavy brick building. It also passed close to a large central gas plant with pipes and gas receivers buried in the ground close to the sewer line. Street crossings of the Lehigh Valley, Central of New Jersey, Lackawanna, Hudson-Manhattan and Pennsylvania railroads had to be passed. In addition to these loads, the sewer was located for 5500 ft.

At the present time three compressor plants are in operation on the work. Those at shafts 1 and 5 are electrically driven and that at shaft 6 has one electric and two steam units. The plant at shaft 5 is typical of the other two, and represents current practice in the layout of such installations. It consists of three units, all two-cylinder low-pressure machines, each driven by independent motors. The combined capacity is 5820 cu. ft. of free air per minute. Each machine may be driven either by an alternating or a direct current motor. The two motors are located at oppo-

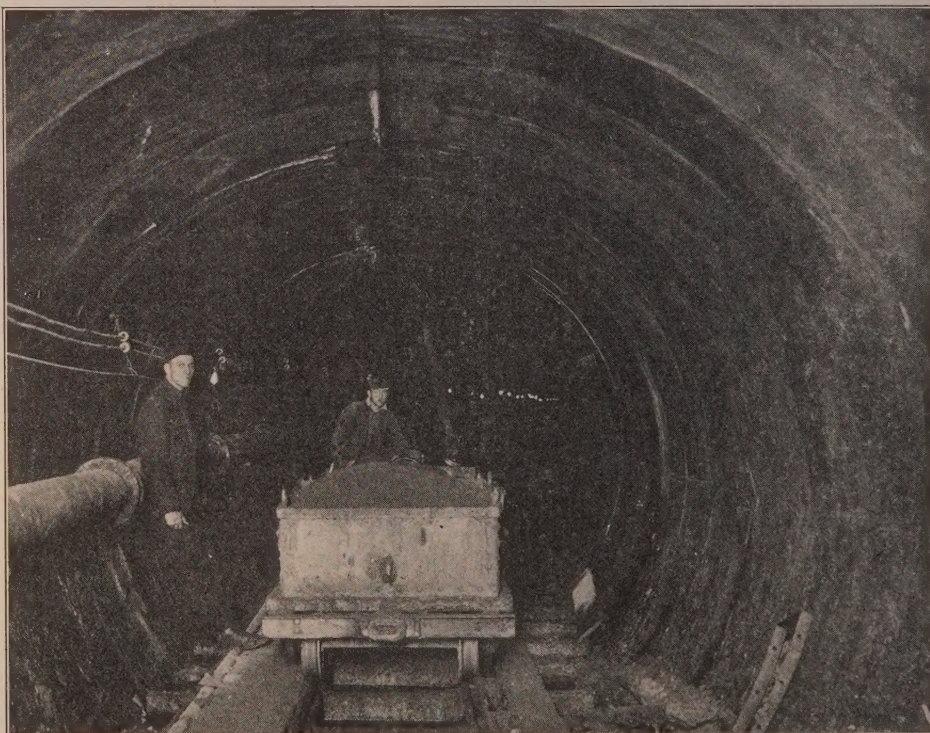
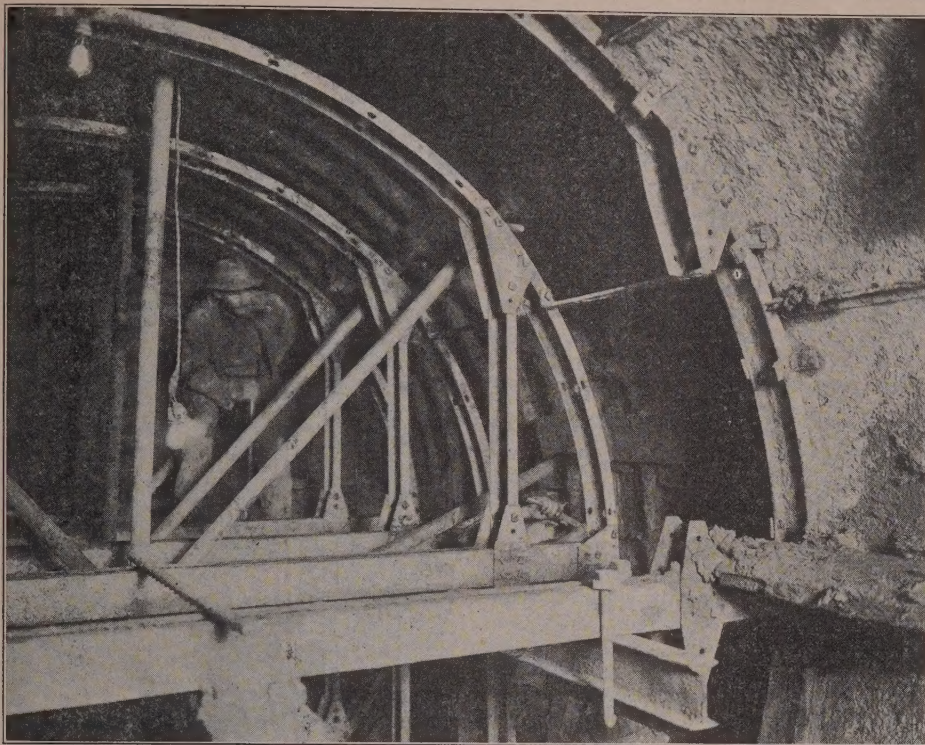


Photo Newark Evening News

TROLLEY BOUND FOR SHAFT WITH LOADED DIRT SKIPS



FORM FRAMES SET FOR CONCRETING 9-FT. SECTION

Shoring jacks remain in place till concrete reaches them, when they are removed to set the face plates of the form.

site ends of a jack shaft, which drives the compressor by belt. The alternating current motor is generally in use, the direct current motor being a reserve in case of an accident shutting off the supply of alternating current. As no receiver large enough to supply the heading for any length of time could be built, it was of vital importance to insure the compressors in this way against stoppage. With this arrangement only a minute is required to change the drive from the alternating to the direct-current motor. A receiver, 6 ft. in diameter by 15 ft. long, is used chiefly to deaden the noise from the machines.

With electric drive it is not possible to regulate the output of the compressors by varying the speed. Throttling the intake was at first tried, but resulted in delivering too much heat and oil into the headings with the air, and further made no great reduction in power consumption. Bleeders 3 in. in diameter were then cut into the discharge of each compressor. To prevent the noise which would have resulted from exhausting these bleeders into the open air, they were piped to a wooden box, 6 x 6 x 4 ft., buried under the compressor-room floor. This box was provided with baffle boards on the principle of an exhaust muffler. All noise was eliminated and the air on passing out of the box was free from oil.

From the machines a 10-in. main takes air to the shaft, where the line branches into two 8-in. mains. Alternating current at 2200 volts is used at this power station without transformation.

SHAFT PLANT

The shaft plant merits description on account of its convenience and flexibility. All concrete, of course, had to be handled at the shaft. It often happened that one heading was concreting while the other was mucking, so that simultaneous means for handling muck and concrete in the narrow shaft had to be provided. The mixers,

therefore, were set at the shaft mouths, and delivered into 8-in. pipes which conveyed the concrete to cars at the tunnel floor. These mixers were fed by gravity from bins loaded in a cheap and convenient manner. Sand and gravel were bought delivered in bottom dump wagons. These wagons drove over pockets in the street, one at each shaft, and dumped directly into them. A light Jeffrey bucket conveyor was swung into the hole as the wagon drove off, and delivered material to either the sand or gravel hopper. Little power was consumed by these conveyors, one of them having actually been driven for months by the motor from a cast-off Fort Wayne electric drill. The bins were of 100-yd. capacity for gravel and 50-yd. for sand, which was ample for concreting a section in each heading. They were left full at night, all concrete material being delivered in daylight.

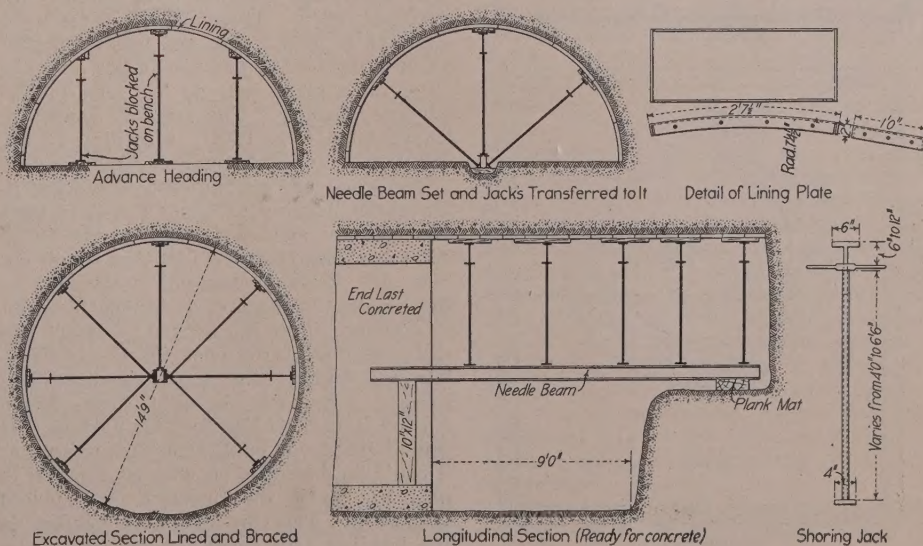
The arrangements for handling dirt at each shaft consist of a two-drum hoist, an

I-beam telfer over the shaft mouth and the dirt hoppers. The hoppers accommodate four wagons and dump by lever gates. The hoppers are set between the hoist and shaft. The general arrangement is shown in the drawing on page 130. One drum of the hoist is wound with a fall line, which drops from the telfer carriage in two parts and carries suspended from its block a detachable bail, which is fastened to the skip by two chains with hooks. The other drum of the hoist is wound endless, with the dead ends of the line fastened to opposite sides of the telfer carriage. The hoist is reversible, so that the carriage may be moved in either direction. Skips are dumped, exactly like caisson buckets, by a short hook-and-line fastened to the telfer carriage and hooked into a ring in the back of the skip. When the carriage reaches the desired hopper the load is lowered, and the hook-and-line takes the weight of the skip and dumps it. To procure level travel of the skip the endless drum is wound so as to move the carriage toward the hoist when the engine is going straight ahead; so that merely keeping the load-line friction in holds the load approximately level, no matter which way the carriage is traveling. Alternating current at 2200 volts is transformed in the hoist house to 220 volts for the surface plant and lights, and 110 volts for the underground trolley.

Automobile trucks were first tried, but proved unsuitable. At the dumps they had to be driven over the fresh fill which, in wet weather, they were not able to negotiate. Team hauling was then used with success. Five or six teams making seven to eight trips apiece during the day, with three teams working at night, were sufficient to keep ahead of the mucking. Dumps were arranged for each shaft so that teams could make a round trip in about 75 min.

UNDERGROUND EQUIPMENT

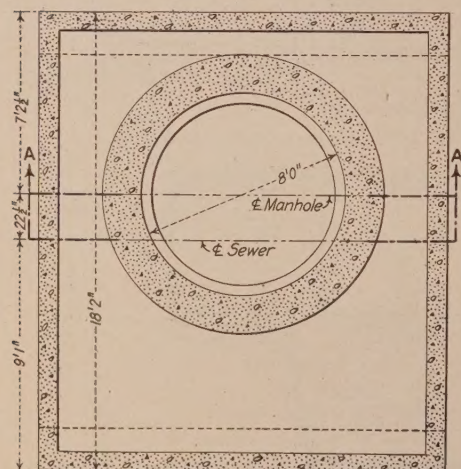
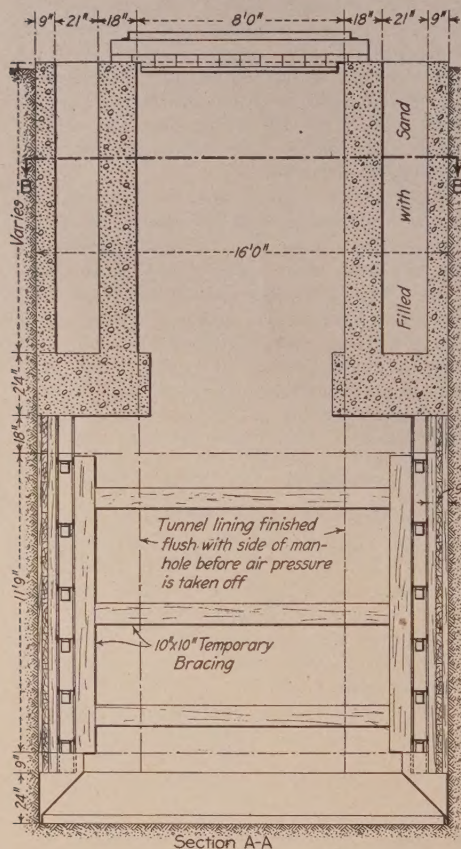
The skips used were shallow $\frac{3}{4}$ -yd. open-end steel boxes, and handled both excavation and concrete. A steel-plate gate closed the open side of the skip when used for concrete. Skips were hauled between the shaft and headings on 30-in. gage cars holding one skip each. As soon as the heading progressed 200 or 300 ft. from the air-lock an electric industrial locomotive was put in service. The tunnel grade was nearly level, and as the locomotive pushed the cars, two at a time, no couplings of



ORDER OF WORK IN EXCAVATING HEADING—LINING SHORED FROM NEEDLE BEAM

any sort were needed. As soon as the lock was moved ahead, as described later, the locomotive would be taken out of the air and put on the long haul from the lock to the shaft; while ahead of the lock the cars were pushed by hand. This locomotive could make the longest round trip—over 6000 ft., at shaft 6, north heading—in 12 min., including switching. Thus the trolley with eight cars (two at the heading, two at the locks, two at the shaft and two in transit) could at all times keep ahead of the muckers. The sewer offered an ideal place for track laying. All ties were cut to the same length, laid level across the invert, and rails were spiked to them. No blocking of any sort was needed as there was no tendency for the ties to slip. Passing switches were provided on each side of the shaft and on each side of the lock.

The other underground equipment consisted of a grout machine, and an electrically driven brake pump, supplying air for drilling in those headings which showed sandstone.



Section B-B
MANHOLE SHAFT CAISSON

Airlocks were built in place by erecting two 30-in. concrete bulkheads 20 ft. apart. Access to the chamber was through a 4½-ft. square steel door, containing a 4-in. bull's eye, in each bulkhead. To allow the doors to close, a 5-ft. removable section of rail is provided in the track. The air space in the lock chamber is cut to 6 ft. square by timbering, which is backfilled with sand.

From 700 to 2000 ft. of tunnel can be driven from each lock before the leakage through pinholes and expansion joints in the tunnel lining amounts to 1000 ft. per minute. After this point was reached it paid to build a new lock near the heading and tear out the old.

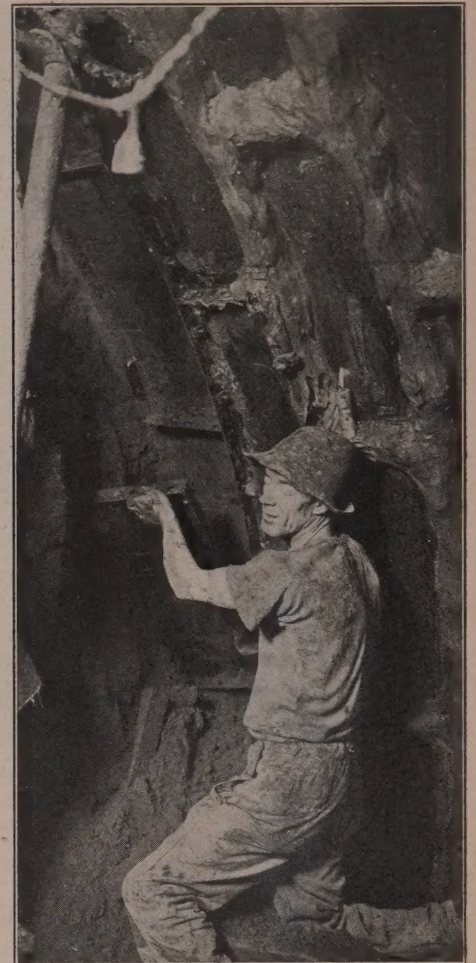
CONSTRUCTION OPERATIONS

The first construction operation was the sinking of caisson shafts, which had to be sunk at each of the four manholes chosen to work from. A sketch of this shaft, about which there is nothing uncommon, is shown herewith. After sinking to grade, that portion of the tunnel within the working chamber of the shaft was concreted. The timber bulkheads on each side of the working chamber were then torn out and tunneling started in each direction. As soon as each heading had progressed about 50 ft., two tunnel locks were built, and air taken off the shaft. The shaft was sunk with an "umbrella" lock and ordinary caisson buckets.

On the Boston Metropolitan sewer system the built plate-and-angle tunnel lining used was more expensive and awkward than the pressed steel plates employed at Newark. A sketch of these plates, which were made by the Hydraulic Pressed Steel Company, of Cleveland, is shown on page 131. One of the features about them is that the plates for all three sizes of tunnel were stamped in the same die. In order to make them fit the other two sections it was only necessary to bend slightly with a hammer the end flanges of a few plates in each circle. They proved to have ample strength, were easily handled and bolted up, and showed advantage in speed and cost over other forms of tunnel lining which require the support of a concrete wall.

The heading method is clearly indicated in the drawing on page 131. Sometimes it was not necessary to set all the jacks shown. The needle-beam was lined and leveled at each heading, and directly supported the cross-frames of the steel forms, thus centering them without further instrument work. These needle-beams were made 15 ft. long. One end was supported on blocking on the finished invert, and the other on a plank mat on the floor of the advance heading. The sections varied in length from 6 to 12 ft., according to the soil, 9 ft. being the usual length concreted.

The worst soil encountered is typified in the north heading of shaft 6. It is very loose, porous sand with some gravel in it. Trouble arises from the fact that it will not hold air. Work in this soil is attended by the constant menace of a serious blow-out if vigilance is at all relaxed. "Mud" had to be kept plastered over the entire heading, and both behind and inside the plate lining. Clay was brought from Perth Amboy in carload lots for this purpose. It was of such good quality for this work that it could be depended on without renewal to hold air until the concrete was placed against it. The clay-and-plank blanket on the heading face could be cut only a few square feet at a time, and the plates had



LINING WITH PRESSED STEEL PLATES
Clay plastered over joints in lining to stop air leaks.

to be set one by one and each "mudded up" before excavating for the next plate. Another formation which gave trouble was "bull's liver," a seam of quicksand, about the center of the tunnel, and overlaid by coarse sand. The weight on top of these seams squeezed them right into the heading, while sufficient air pressure to hold them back would have caused a blow-out. Neat cement had to be sprinkled liberally on these seams to stiffen them as excavation progressed. It was in the headings which showed all fine sand that the best progress was made. It was not necessary even in the worst sections to line the bottom of the invert. About thirteen lining plates to a circle generally were used.

FORMS AND CONCRETE

As soon as excavation for a section was complete the forms were set up and concreted. These forms were designed by the contractors, and made by the Blaw Steel Construction Company. The frame was first set up with the cross-braces resting on the needle-beam. The form plates which made the form surface were bolted on as concreting progressed. The framework was made adjustable for the different sizes of tunnel. The plates, which were 3 ft. square, were originally curved to the 11 ft. 9 in. radius, and later sprung to fit the other two circles. The variation in circumference was taken care of by plates of different widths, two of which went in each form section, one on either side of the key-plate at the top. In the transition sections between the different diameters of tunnel the steel plates were used, but had to be supported by wooden framework.

The frame being in place, concrete was started. When a skip reached the heading the gate was drawn and the skip tipped up with a long bar till the concrete ran out of it, directly onto the dirt. When concrete reached the bottom of the invert two rows of plates were bolted on the form, and a low platform put on them to hold concrete from the skip. As soon as these plates were backfilled with concrete the next row on each side was bolted on and filled. This continued till the concrete reached the level of the center of the tunnel, when the platform had to be raised, and the rest of the concrete for the section shoveled onto it from the skip. The jacks were taken out just before setting the form plates, so that only one row of pressed-steel lining on each side was left unsupported at a time. The crown plates were placed and filled, a 3-ft. section at a time. Six hours were usually required to concrete a 9-ft. section in this way. The contract volumes per linear foot of tunnel for the three sizes were 1.82 cu. yd., 1.90 cu. yd. and 2.49 cu. yd.; the actual volumes placed were somewhat greater.

GROUTING

Inside the sections under air one or two men to each heading were kept busy finding and grouting air leaks. The expansion joints were chipped out to a depth of $1\frac{1}{2}$ to 2 in. and plastered with cement mortar. In addition, every 30 ft. a 2-in. pipe was left in the roof, through which grout was forced. It was shown in sinking shaft 2 after the completion of the tunnel that this grout had filled all voids between the concrete of the arch and the pressed steel lining, and had also worked through the joints of the lining and formed a thin coat between the outside of the steel and the ground, over the entire space covered by the shaft.

These precautions were taken not only to comply with the specifications, but also for the contractor's benefit. As the tunnel was not waterproofed, and as concrete placed under air has a tendency to be porous, the air leakage would otherwise have made necessary the building of many extra locks to shorten the heading length. As a result of these efforts the leaks after taking off air were negligible.

PROGRESS

At present the work on this contract is over 85 per cent completed, and over 7000 ft. of tunnel has been finally accepted. The record rate of progress for one heading—nine 9-ft. sections concreted in one week—has been made twice, both in an 11 ft. 3 in. and in an 11 ft. 9 in. heading. The progress record for one shaft for a single week and a single month were both made at shaft 5, in two 11 ft. 9 in. headings. Here 127 ft. of tunnel was completed in one week, and 488 ft. in one month. A higher shaft record would undoubtedly have been made except that it never happened that both headings at once were in ground favorable to progress for any length of time. The north heading at shaft 5 contained a considerable per cent of rock. The original contract called for the completion of the work by Jan. 1, 1916. Both the original contract and the two additional sections, however, will be completed before that date. Work at shafts 1, 3 and 6 is completed, leaving only shaft 5 in the center of the contract to be finished. All the manhole shafts are finished with the exception of shaft 4.

The working force is in charge of a general superintendent. Each shaft is in charge of a shaft superintendent, who has under him a surface foreman and a foreman for each heading. From three to six men are employed in the surface gangs beside the power house and hoisting engineers. Below ground two men are usually required to shift cars under the shaft. There is an outside tender for each lock, and a trolley runner for each heading. The heading gangs consist of two miners and two helpers, and from four to eight muckers for each shift, beside the men engaged in grouting and patching.

The work is being done by Booth & Flinn, Ltd., for whom Le Roy Tallman is general superintendent. The shaft superintendents are William Rushford at shaft 1, A. McDonald at shaft 5, and William Murphy at shaft 6.

A National "Factor of Safety"

To Be Provided by Giving Engineers Such Instruction in Military Matters as Will Fit Them for Commands in Emergencies

By WILLIAM R. KING
Consulting Engineer, New York City

THE lesson to be derived from that frightful cataclysm now devastating the most intensively developed and densely populated portions of Europe is one which, to judge from current Congressional activity as well as from the prevailing tone of the daily press, is happily not being overlooked or neglected by our citizens of thoughtful habit. A coincident realization of the inadequacy of the provision taken for our national defense—the unfortunate result of our National egotism, optimism and indolence as applied to affairs political—has been abruptly brought to our attention and merits instant recognition and consideration.

Eliminating from consideration as incompatible with our National precedents all ideas of a "vast standing army," of a "military establishment for the purpose of offense"—catch phrases in the present heated discussion, which only tend to cloud the real matter at issue,—and at the same time setting aside all maudlin sentimentality and altruism, the necessity of adequate provision for our National defense must appeal to every member of the engineering profession, in which the theory and practice of "defense," not only against the normal and recognized but also the unusual and extraordinary effects of the forces of nature, is, through education and practice, predominant.

Assuming, therefore, that to the trained engineer, in the consideration of affairs political as well as of affairs physical, the inclusion of an adequate *factor of safety* is essential, a brief survey of the situation may be of interest.

A WAR OF THE ENGINEER AND HIS CREATURES

The present European conflict, as must be self-evident to every student of the situation, is a war by the engineer and of his creatures—mechanisms of destruction. Engineering skill, with its production of aeroplanes and Zeppelins, armored railway trains and automobiles, 42-cm howitzers and rapid-fire artillery, submarines, searchlights and the wireless telegraph has sustained the burden of active offense and defense. To Germany's preeminence in the field of technology, as applied to

military science, may be accorded all credit for her so far overwhelming success.

What provision have we made for securing an adequate engineering force, in our program for National defense?

Our standing army, an efficient and excellently equipped body of men, adequate for service as a force of international police, would form in time of great National danger little more than a nucleus around which to assemble our volunteer army of defense.

Although fully believing that when the critical hour shall arrive the now latent patriotism of our heterogeneous community will, as in the past, nobly respond to fill positions in the rank and file, yet to equip, officer and train this force of willing volunteers in defensive warfare against an enemy led by those especially skilled and trained in the art of military engineering, will require the services of countless engineers who must be even more proficient than their enemies in the military branch of their calling.

WEST POINT OUTPUT INADEQUATE

West Point, with its annual output of approximately 100 graduates, men of the highest professional standing and of undoubted attainments, is capable of furnishing a trained force but little in excess of that necessary to meet the requirements of our standing army in time of peace.

The National Guard, our main dependence, an organization now largely deficient in that prestige and popularity so essential for its growth and efficiency, will undoubtedly furnish its limited quota of capable officers, well grounded in military tactics and the manual of arms, but of necessity, from lack of technical education, deficient in that specialized knowledge of engineering now so necessary for the construction, operation and maintenance of the complicated mechanisms indispensable for successful resistance against invasion.

Hence, it is largely upon the civilian engineer, handicapped as he is by lack of military training, that we must place our trust and dependence.

Granting the existence of this responsibility, which must eventually devolve on the engineering profession, would it not be well to provide now for the contingencies of the future? Should we not hereafter so shape the education of the undergraduates of our numerous technical institutions that they may be thoroughly grounded in, at least, the elements of that subdepartment of military engineering which may accord with their special branch of study?

Familiarize the Civil Engineer with the construction of permanent and temporary fortifications, with rapid road, railroad and bridge reconstruction; the Mechanical Engineer with the design, manufacture and operation of arms, ordnance, and projectiles, of torpedoes, submarines and aeroplanes; the Electrical Engineer with various systems of military communication, with the electric operating mechanisms of heavy ordnance, turrets, etc., with the placing and exploding of submarine mines; the Mining Engineer with the construction of earthworks, approaches and terrestrial mines; the Chemical Engineer with the practical manufacture of military explosives.

By this, and by this means only, can we provide the large and efficient corps of technically trained officers which will be required to guide our army of defense.



THE ELECTRIC TOWING LOCOMOTIVES, OPERATING ON RACK RAILS, ASCEND GRADES OF 44 PER CENT AT THE LOCKS

Electric Towing Locomotives Chief Feature in Operation of Panama Canal

Forty Powerful Hauling Units, Operating on Rack Rails, Afford Complete Control Over Movement of Vessels Independent of Their Own Power

SAFETY in the passage of vessels through the locks of the Panama Canal is assured by a towing system involving forty electric, rack rail locomotives which have been designed to afford such complete control over moving vessels, independent of their own power, that the possibility of a great ocean steamship breaking through the gates of the upper locks, and plunging down through those below is effectively minimized, if not entirely eliminated. Each of these powerful hauling units weighs 86,300 lb., is capable of exerting a tow line pull of 25,000 lb., has a maximum towing speed of 2 mi. per hour, and is capable of climbing up grade as steep as 44 per cent. Every vessel passing through the locks will be maneuvered by four of the towing locomotives, two off the bow doing the pulling and two at the stern serving to guide, retard or stop the ship. After a very thorough study of the entire problem of maneuvering ships through the locks of the canal, it became evident that they should not proceed through the locks under their own power, and that a substitute for the ship's power should meet the following requirements: Place the ship in proper relation to the lock; keep the ship to its course; accelerate and retard the ship without rupturing the lines; tow the ship without the necessity of changing the lines for lockage in flight; require a small number of skilled operators rather than a large number of unskilled men to coordinate. With these basic principles in mind the towing system at Panama was designed and patented by Edward Schildhauer, electrical and mechanical engineer of the Isthmian Canal Commission. The

forty towing locomotives and all the electrical apparatus for operating the locks were built by the General Electric Company.

THE ROUTE THROUGH THE CANAL

In passing through the canal from the Atlantic to the Pacific, a vessel will enter the approach channel in Limon Bay, which extends to Gatun, a distance of about 7 mi. At Gatun it will enter a series of three locks in flight and be raised 85 ft. to the level of Gatun Lake. It may then steam at full speed through the channel in this lake for a distance of 24 mi. to Bas Obispo, where it will enter the Culebra Cut. It will pass through this cut, which has a length of 9 mi. and reach Pedro Miguel, pass through Miraflores Lake for a distance of 1½ mi. until it reaches Miraflores,

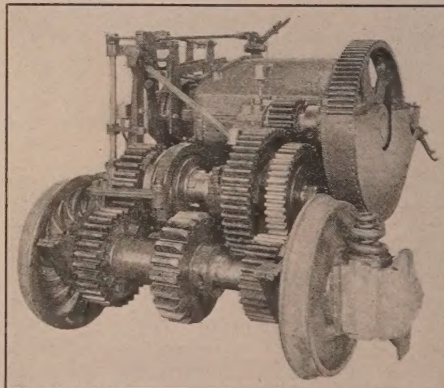
where it will be lowered 55 ft. through two locks, to the sea level, after which it passes out into the Pacific through an 8½-mi. channel.

The main features of all the lock sites are identical. The following brief description of the Gatun Locks, with special reference to the arrangement of the towing tracks, ship channels, inclines and approaches, is given to enable the reader to obtain a clearer conception of the towing scheme in general, as well as the more detailed description of the locomotive.

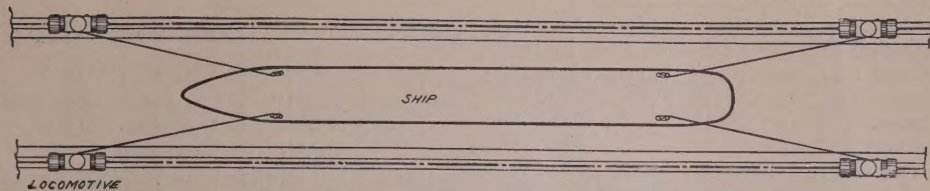
At the Gatun Locks there are two ship channels, one for traffic in each direction. The channels are separated by a center wall, the total length of which is 6330 ft. There are two systems of tracks, one for towing and the other for the return of the locomotive when returning idle. This, however, refers only to the outer walls. For the center wall, there is only one return track in common for both the towing tracks. The towing tracks are naturally placed next to the channel side, and the system of towing utilizes normally not less than four locomotives running along the lock walls. Two of them are opposite each other in advance of the vessel, and two run opposite each other following the vessel. The number of locomotives is, however, increased when the tonnage of the ship demands it.

CONTROL OF SHIP MOVEMENT

Cables extend from the forward locomotives and connect with the port and starboard sides respectively of the vessel near the bow, and other cables connect the rear locomotives with the port and starboard quarters of the vessel. The lengths of the various cables are adjusted by a special winding drum on the locomotive to place the vessel substantially in mid-channel. When the leading locomotives are started they will tow the vessel, while the trailing locomotives will follow and keep all the cables taut. By changing the lengths of



FRONT OF TRACTION MOTOR UNIT WITH JOURNAL BOX IN PLACE



FOUR LOCOMOTIVES MANEUVER EACH SHIP—TWO FOR TOWING AND TWO FOR RETARDING MOVEMENT AND CONTROLLING POSITION

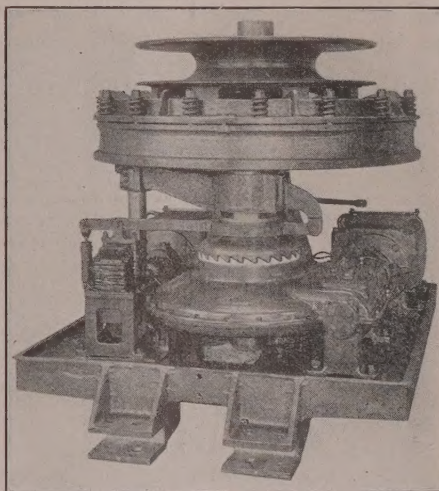
the rear cables, the vessel can be guided. To stop the vessel, all the locomotives are slowed down and stopped, thus bringing the rear locomotives in action to retard the ship. Therefore, the vessel is always under complete control quite independent of its own power, and the danger of injury to the lock walls and gates is greatly lessened.

RACK RAILS FOR TOWING TRACKS

The towing tracks have a specially designed rack rail extending the entire length of the track and located centrally with respect to the running rails. It is through this rack rail that the locomotive exerts the traction necessary for propelling large ships and climbing the steep inclines. A rack rail is also provided on short portions of the return track so as to lower the locomotives safely from one level to the next. The steepest slope is 44 per cent, hence the need for rack rail, even on the return track. With a rack rail traction is limited only by the capacity of the driving motors and not by the adhesion of the wheel treads on the rails.

The rack rail is of the shrouded type, and each tooth space has a drain hole cast in the bottom so as to carry off water and other accumulations. A further feature is the projecting edges, which permit thrust wheels attached to the locomotive to run along the under side and prevent overturning of the locomotive in case some unforeseen operating condition should produce an excessive pull on the towline. These thrust wheels serve to counteract the lateral component of the tow line pull, and the flanges act for emergency only, as the weight of the locomotive is sufficient to prevent overturning with a normal pull of 25,000 lb. on the towline.

Three-phase, 25-cycle, 220-volt alternating current is used for operating the locomotives, and the current is supplied to the locomotives through an underground contact system. The working parts of the locomotive are supported by two longitudinal upright side frames of cast steel, connected by transverse beams. These frames



WINDLASS AND BASE ASSEMBLED

are, in effect, deep rigid trusses having upper and lower members connected by posts and diagonal braces. The pedestals for the wheel axles are located at the junction of the end portions with the middle portion of the frame and are of the usual locomotive type, having vertical parallel jaws between which the journal slides. Springs are interposed between the tops of the journal boxes and the tops of the

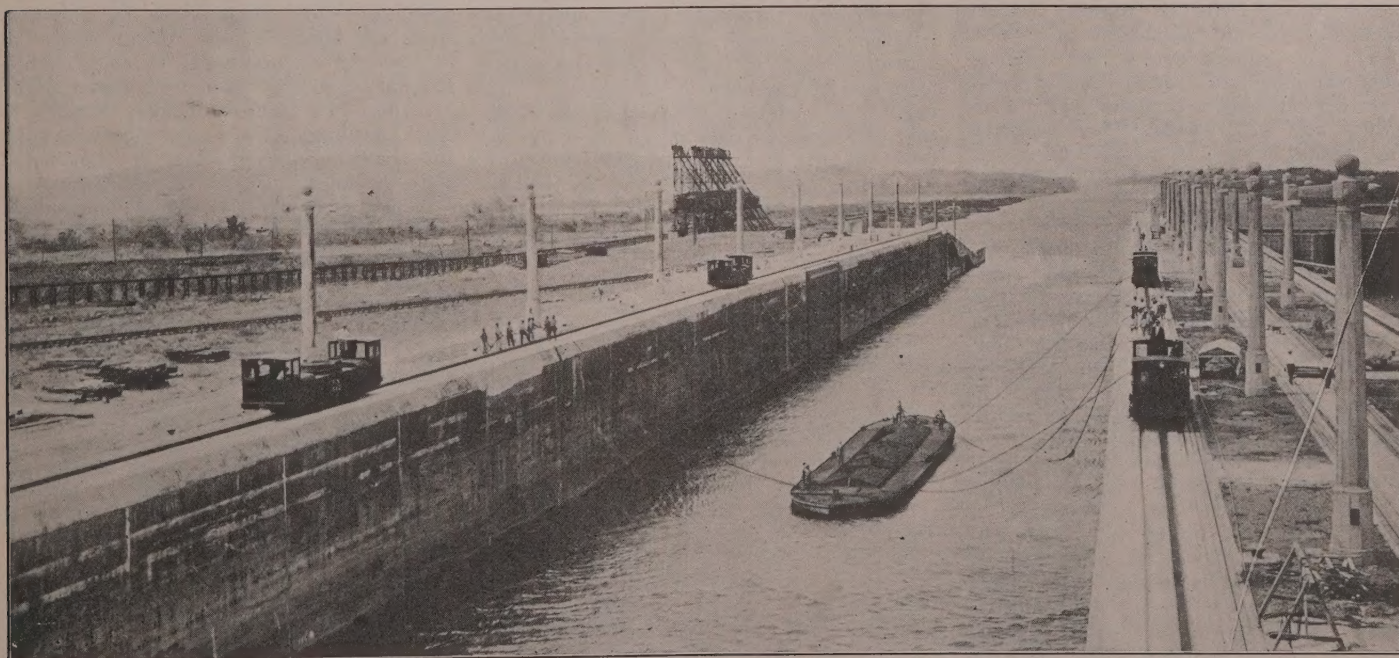
pedestals, and the locomotive is thus mounted upon four wheels carried on the two axles. The wheelbase is 12 ft., and the overall length of the locomotive over 32 ft.

Each axle is driven by its own 75-hp. motor, independent of the other, and the construction is the same at both ends. The motor is of the three-phase, slip-ring type, enclosed and identical with the rugged steel mill design. When running without load and between inclines the motor propels the locomotive by the adhesion between the wheels and the rails of the track, but when the locomotive reaches one of the steep inclines between the locks, or when it is towing a ship, the cog rail system is utilized. The towing speed is 2 mi. and the return speed 5 mi. per hour.

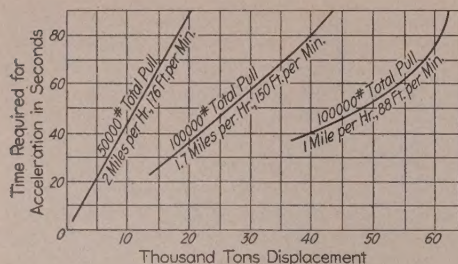
The two traction motors are controlled by suitable controllers installed in the cabs at the ends of the locomotives. The circuits are such that both motors can be controlled from either cab, and can be operated singly or in multiple as desired. Each motor, with all its gearing and clutches, is mounted independently of the frame of the locomotive, to which it is connected only by springs which give an elastic support for the outer end of the bracket on which the mechanism is carried. In connection with each motor is a brake, powerful enough to stop the locomotive within two revolutions of the wheels.

CABLE DRUM

Passing to the features which render the locomotive peculiarly adapted for towing purposes, the drum on which the cable is wound is located midway between the ends of the locomotive and above the upper member of the side frames, so that the cable can be led off on either side of the machine and through a wide range of angles to the line of travel. One motor, with bevel gear pinion, is used for driving the drum at a high speed when coiling the cable that has been cast off, and it remains permanently in gear. Another motor, with worm gear drive, is used for taking in the cable when it is under load, and the drum operates as a windlass or capstan. Due to the greater gear reduction, it operates the drum at a much slower speed; consequently, with



THE FIRST TRIAL RUN AT GATUN—SEPARATE SYSTEMS OF TRACK FOR HAULING AND RETURN PREVENT TRAFFIC CONGESTION



TIME REQUIRED FOR THE ACCELERATION OF SHIPS

motors of approximately equal size, a greater force may be exerted on the tow line than would be possible with the lower speed reduction which is used with the high-speed coiling motor.

One of the most important parts of the locomotive is the slip-friction device consisting of two special alloy rings, mounted on the spider. Between these rings a steel disc is fastened to the rope drum. The amount of tension on the tow line is adjusted by the pressure between these three discs and is obtained by tightening the spiral springs on the clamping ring. In order, therefore, to make the slipping tension of the towline proportional to the pressure between the friction discs, a rubbing surface of metal having an absolutely constant coefficient of friction of 0.1 was developed by test.

SHIP ACCELERATION

The curves in the accompanying diagram give some interesting data on the time of acceleration of ships in the lock chambers. These values have been obtained from certain tests and theoretical calculations based on data given by several well-known authorities.

Census of Primary Power Equipment

Government Report Shows an Increase of 463.6 Per Cent in a Decade or from 438,472 to 2,471,081 Horsepower

THE DEVELOPMENT of water power in the United States in 1912 is dealt with in a report of the Census Bureau which has recently appeared in printed form. The report covers the primary power equipment of central stations using steam engines, steam turbines, gas and oil engines and waterwheels. The classification is changed somewhat in the return for the three census periods of 1912, 1907 and 1902. Steam turbines were shown separately in the two later reports, while in the report of 1902 they were included with steam engines. Auxiliary engines were dealt with in a separate chapter in 1902 and 1907, but were not reported separately in 1912. The accompanying diagram shows a comparison between the primary power charts of 1902, 1907 and 1912.

In the accompanying table is shown the development of water power. The total water power of commercial and municipal electric central stations increased from 438,472 hp in 1902 and 1,349,087 hp in 1907 to 2,471,081 hp in 1912. The increase in the decade was 463.6 per cent. In the two later census periods waterwheels and water turbines contributed approximately one-third of the total primary power of central stations. The great increase was in the large units. The total

rating of water turbines of 5000 hp or more increased 222 per cent from 1907 to 1912. Of the total horsepower rating of waterwheels and turbines in 1912, commercial stations had 94.7 per cent and municipal stations 5.3 per cent.

The returns show that water power was used for the generation of electrical energy in all States except Kentucky, Louisiana, Mississippi, North Dakota and the District of Columbia. Including the returns from electric railways the rating of all waterwheels increased 104.2 per cent from 1907 to 1912.

The water power reported for New York, California, South Carolina, Pennsylvania, Michigan and Montana combined was 60 per cent of the total for the United States.

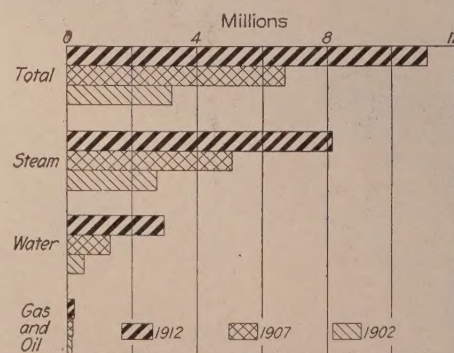
Water power was reported as used by 1035 central stations in 1912, and of these 496 reported having only water power. Of the latter number 225 stations reported

WATERWHEELS AND TURBINES—1912, 1907 AND 1902

Class of stations	Machines grouped according to horsepower			
	500 hp or under	Over 500 and under 2000 hp	2000 and over 5000 hp	5000 hp and over
Total, 1912.....	333,795	594,440	448,760	1,094,086
1907.....	320,636	357,671	330,980	339,800
1902.....	174,559	156,613	107,300	.....
Commercial, 1912.....	298,674	554,100	441,960	1,046,086
Municipal, 1912.....	35,121	40,340	6,800	48,000
Per cent of increase:				
Total, 1902-1912.....	91.2	279.6	318.2	.....
1907-1912.....	4.1	66.2	35.6	222.0
Commercial, 1902-1912.....	81.0	257.5	311.9	.....
1907-1912.....	0.7	55.8	35.3	207.9
Municipal, 1902-1912.....	266.7	2,359.8	.....	.....
1907-1912.....	46.7	1,917.0	54.5	.....

*Included in "2000 and under 5000 hp." The class "5000 hp and over" was not called for at the census of 1902.

water power each of 1000 hp or more. These were tabulated separately in the census returns as representing the hydroelectric stations. Their cost of construction and equipment was \$922,954,341 and their total income was \$72,717,582. These stations form only 4.3 per cent of the total number of central stations, but they reported 42.2 per cent of the aggregate horsepower, 92.6 per cent of the water power, 38 per cent of the dynamo capacity, 50.8 per cent of the kilowatt-hour output, 31.1 per cent of the horsepower of stationary motors, 42.4 per cent of the cost of construction and equipment and 24.1 per cent of the income. That much of the business of these plants is the sale of energy in bulk is indicated by the fact that they had only 12.4 per cent of the arc lamps and 17.5 per cent of the incandescent lamps. They reported 46 per cent of the total income for energy sold to other public service corporations.



PRIMARY POWER CHART, 1902-1912

Strength of Columns Sought by Full-Size Tests

Elaborate Equipment Used by Special Committee of American Society to Determine Behavior Under Service Conditions

THAT extreme care is being taken by the special committee on steel columns and struts of the American Society of Civil Engineers in the full-size tests being made by the committee is shown in the outline of instructions for testing columns, as given in the progress report submitted last week at the annual meeting of the society. The investigation at present embraces nine different types of cross-sections of the society's series and one of the American Railway Engineering Association's series. Of each type there is a light and a heavy section, and, in turn, of each of these there are three lengths, namely, of 50, 85 and 120 L/R. In addition there are a number of steel bridge members being tested.

Before testing the columns are weighed and gaged for size, the riveting is inspected, any bends, waves or kinks in alignment are noted, the column ends are redressed to insure perfectly uniform bearing, and the two longer sets of columns, that is, those of 85 and 120 L/R are counterweighted at the middle by a load equal to one-half the total column weight.

The actual areas of these column sections show a variation as great as 4 per cent from the nominal. Some standard method had to be chosen which would give the correct areas. The shapes were first calipered at the ends and variations were noted. Then prints were made on white paper from the blackened ends of the columns, and the areas obtained by the use of the planimeter. Finally, the columns being weighed and the rivet heads deducted, the areas were determined by the specific gravity of the material. This last method was adopted as the proper one in determining the unit loadings.

MEASUREMENTS AND OBSERVATIONS

The instructions for measurements and observations to be made during the test are very complete and precise, due to the elaborate equipment. Strain-gage measurements are taken from 8 to 10 in. apart along the length of the column—those at the end far enough away to avoid effects of local distortion. Compressometer measurements are made on longer lengths to check the short strain-gage measurements, and deflection observations on horizontal and vertical movements at the middle of each test piece are also taken. Permanent sets on changes in cross-section are determined at loading intervals of 5000 lb. per square inch up to 15,000 lb., and then intervals of 1000 lb. per square inch up to 130,000 lb. Horizontal and vertical deflections are observed at the time of measuring longitudinal compressions and sets. The general direction taken by the column when it fails, and whether this is due to deflection as a whole or to local buckling, are noted. Careful note is made where the column begins to scale, and of the lines of scale, and the condition of the rivets is recorded around the distortion points.

After the ultimate load has been reached, at least one column of each cross-section and length is compressed to emphasize the manner of failure. This column is photographed both at the time the ultimate load is reached and after being compressed.

Construction of Cumberland Waterworks

Hauling Problems, Layout at Dam Site, Including Quarry and Cement-Block Plant, and Excavation for Nine-Mile Wood-Stave Conduit

By FRANK H. EASTMAN

Engineer in Charge for the Merrill-Ruckgaber Company, New York, Contractor

COMPLETION of the Cumberland (Md.) water-supply system, comprising an 80-ft. masonry dam, a 9-mile conduit, principally of wood staves, a mechanical filtration plant with a capacity of 6,000,000 gal. per day, and a 500,000-gal. storage reservoir, was signalized on Sept. 15, 1913, when water was turned into the city mains. In the Engineering Record of Sept. 14, 1912, the proposed works, construction of which had begun, were described in detail. The present article will, therefore, deal only

This type of engine was particularly adapted to the work at this point, the cost of current averaging \$3 per month. As compared with steam power, it was much cheaper and had the advantage of being ready for instant use. Of the 12,000 tons hauled about one-half was carried with the two trucks. In good weather, with the roads favorable, each truck made five trips every twenty-four hours. The cost was greater than for team haul on account of the loss of time by the drivers and the

for fill was deposited in front of the dam, the remainder being spoiled below. The hardpan had to be excavated to rock with pick and shovel and removed with the derricks. As soon as the concrete in the west side was level with the creek a cofferdam was constructed across the stream and the channel turned into a flume across the finished work. Excavation below the creek bed and on the east bank was removed by means of 1-cu. yd. dump buckets handled by stiffleg derricks. The permanent 48-in. blowoff pipe was then concreted in and the stream turned back through it.

From the power plant, consisting of boilers, air compressor and pumps, situated centrally on the creek bank below the site, steam was piped to the engines and air to the quarry for the drills. To handle the large stone for the cyclopean masonry and to set the facing blocks five derricks were erected—a steel guy derrick with 110-ft. mast and 100-ft. boom below the dam in the center, on either wing a stiffleg derrick, one with a 60-ft., the other with an 80-ft. boom, and two others of the same type on the upstream face, one at the extreme east end and one in the center, built on cribs to enable materials to be passed over the finished dam. The steel guy derrick was found to be well placed, as it occupied little space and was easily erected and operated, and but for the advantage gained by framing the wood structures on the ground, this type would have been used altogether.

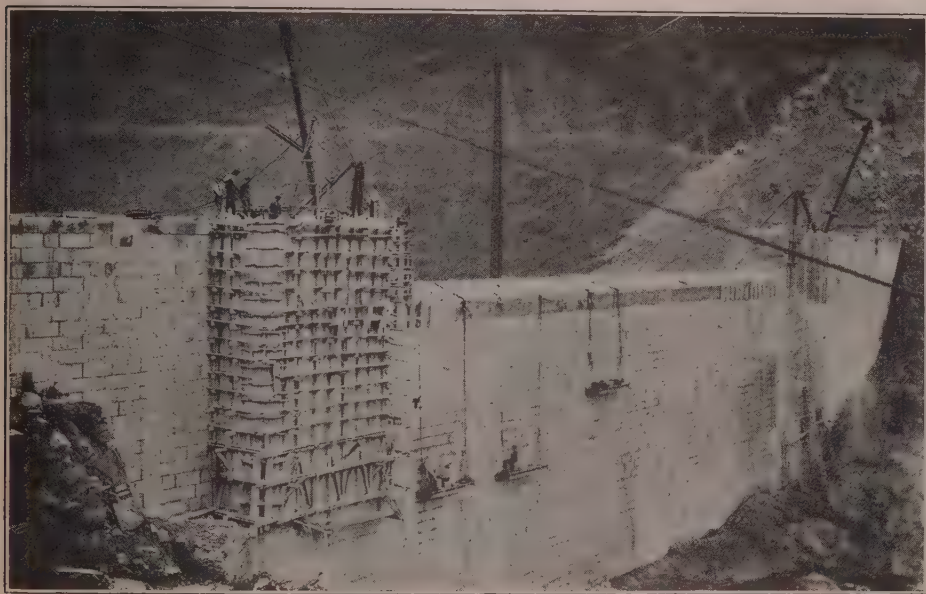
QUARRY

The quarry was opened on the west hillside above the elevation of the dam crest.

A 12 x 24-in. Reliance jaw crusher with manganese steel jaws was located just below the quarry, and the crushed rock was carried by belt conveyor and deposited in a 600-cu. yd. bin, from which it was fed by gravity into the mixers beneath. The crusher averaged 200 cu. yd. in twelve hours and gave a consistent performance, breaking approximately 26,000 cu. yd. without a breakdown and with no expenditure for repairs. The large stone for cyclopean masonry was quarried about 1000 ft. below the dam. Rocks weighing as much as 10 tons were loaded direct to flat cars by means of a traveling derrick and hauled up an incline within reach of the derricks below the dam, the empty cars returning by gravity to the quarry.

Sand was obtained from the bottom lands above the dam site. It contained about 40 per cent loam and some boulders and coarse gravel. The creek was dammed far enough upstream to get the required head and a plank flume was built from this point to a pit near the mixing plant. A series of baffle boards was arranged below the pit to carry off the waste and water and allow the good sand to settle in the pit, from which it was scooped out and hoisted on a screen which allowed the sand to pass through into bins, from which it was hauled up an inclined track by a single-drum hoisting engine located at the top of the incline, and dumped into the storage bins, which had a capacity of 300 cu. yd. and which fed by gravity to the mixers. The sand material was excavated by means of a 1-cu. yd. Iverson drag-line bucket operated on a traveling stiffleg derrick and carried to the flume in Koppel cars. This method of excavation was tried out as an experiment in an effort to reduce the cost of hand excavation and was a decided success.

Storage was provided underneath the



UPSTREAM FACE OF DAM—FORMS IN PLACE FOR GATE HOUSE

with the more important of the problems involved in the construction.

All men engaged on the work were housed at the site of the dam—laborers in stanch shacks, where they did their own cooking, and mechanics in buildings accommodating four to eight men, who were boarded at a dining room run by the contractor at a financial loss, counterbalanced by the fact that the men were kept in good humor.

HAULING WITH TEAMS AND MOTOR TRUCKS

It was necessary to haul supplies over 9 miles of country road—macadam for 2 miles at the railroad end and dirt for the balance—with several steep sandy hills. In any kind of wet weather these 7 miles were practically impassable. A ¾-mile stretch leading from the camp across a flat piece of farmland was corduroyed. It was foreseen that the chief difficulty would be met in getting materials in, especially in quantities to maintain the rate of progress desired. As teams were mostly of an inferior grade and transient, belonging chiefly to farmers in the vicinity, two motor trucks were added to the hauling force—a 6½-ton Saurer and a 5-ton White. The 650 cars of material used in the construction were shipped into Cumberland over the Baltimore & Ohio Railroad and unloaded with a stiffleg derrick operated with a Lidgerwood 25-hp electric hoisting engine, current being obtained from the local power company.

frequent breakdowns and tire trouble due to the condition of the roads. A heavy rain for a day or two would sometimes put the trucks out of commission for a week, but they did their best work during hot weather, when the teams were unable to keep on the road. A fair comparison of costs is impracticable on account of the difficulties of the winter months. For the full time—eighteen months—the trucks were 30 per cent more expensive than the teams, but for the summer months only the trucks were 25 per cent cheaper.

EXCAVATION PLANT

Work on the dam comprised placing 24,000 cu. yd. of 1:3:6 cyclopean masonry and covering both faces with 1:2:4 concrete blocks, of which there were about 5000 cu. yd. Excavation, which totaled approximately 5000 cu. yd. of earth and hardpan, 7500 cu. yd. of rock and 8000 cu. yd. of fill and embankment, was begun January, 1912. The creek was allowed to flow in its natural channel until the excavation on the west bank was completed and the placing of concrete started. On top of the rock in the valley bottom is a 12-ft. layer, half earth and half hardpan, excavation of which was accomplished by means of a 15-cu. ft. orange-peel bucket rigged to a traveling stiffleg derrick and operated with a triple-drum hoisting engine and a small independent swinger. The excavation suitable

material bins for 1500 bbl. of cement which were brought across the creek from the unloading device to the storage room on flat cars hauled by a small vertical engine, the empty cars returning by gravity. Water was supplied from a tank placed over the charging hoppers and filled from the pumping plant. Directly beneath the storage bins were located two $\frac{1}{2}$ -cu. yd. Haines-Weaver mixers, which discharged into buckets in a double tower, up which the concrete was hoisted to the elevation of the top of the dam, where it was chuted to cars on a trestle so built as not to interfere with the placing of the blocks and large stone. The situation of the quarry in respect to the work made the type of mixer used the only one practicable. It took up little room, necessitated low operating expense, and no repairs were required for the whole job. Where possible, moving the concrete was effected, instead of by cars, by buckets handled by the derricks. From 200 to 400 cu. yd. were placed per day of ten hours.

CEMENT-BLOCK PLANT

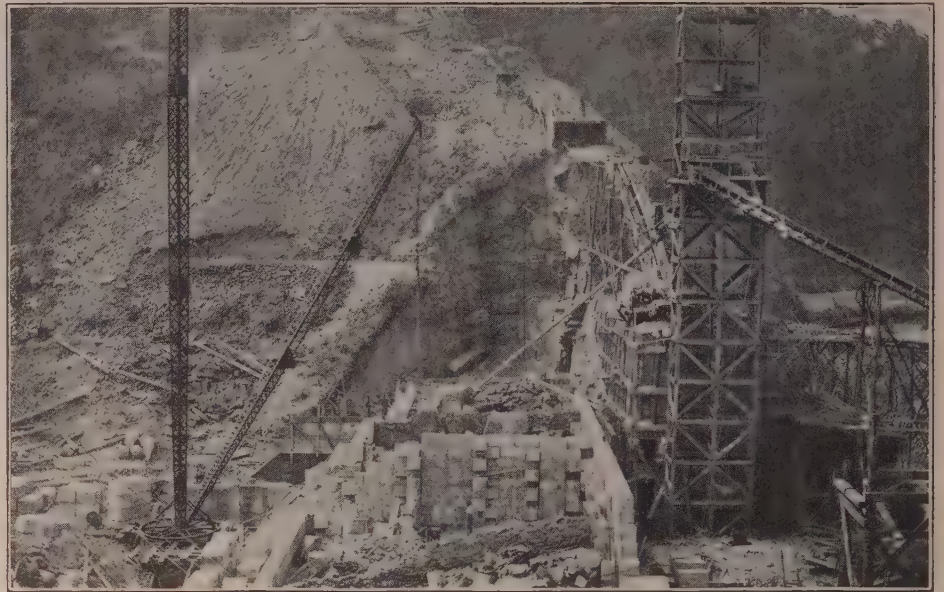
No forms were required except for the spillway walls and the gate house, the front and back exposed faces of the structure being faced with concrete blocks of different shapes. There were twenty-nine different sizes of blocks, varying from 2 cu. ft. to 2 cu. yd. As the specifications required that the blocks be seasoned two months before they were placed in the work, it was necessary to provide for their manufacture on a large scale. On account of the available supply of material and the distance from any other source, it was advisable for the contractor to manufacture his own blocks on the ground. On the flat above the dam site a platform was built of rough 2-in. plank and covered with sheet iron. The forms were made up of dressed 2-in. lumber and put together in panels held in place by bolts. The concrete was spouted through an open sheet-iron chute supported on a trestle from the tower to a hopper which discharged into buckets placed on open-bottom flat cars. These were run out on temporary light trestles erected over the block forms, dumping direct to the forms. As soon as the concrete had received its initial set the forms were removed and the blocks left in place until strong enough to stand being lifted to the storage piles with the derrick, where they were sprinkled and left to cure before being placed in the work.

PIPE-LINE EXCAVATION

From the dam to the distribution reservoir near Cumberland, a distance of 46,500 ft., a 36-in. main was laid, 45,670 ft. of wood-stave and 880 ft. of cast-iron pipe. The excavation was principally through a rocky, mountainous country, which had first to be cleared of trees. The trench was 5 ft. in width at the bottom and followed the contour of the ground to give a depth of from 2 to 3 ft. cover over the pipe; but in cases where a sharp break in the contour occurred it was necessary to excavate as deep as 20 ft. to carry the conduit in a vertical curve of not less than 300 ft. radius. At some points where it would be impractical to excavate to so great a depth to get the required curvature, special cast-iron bends were put in. The nature of the soil and contour made any kind of excavation except by hand labor inadvisable. For approximately 2 miles the cut was through loamy gravel mixed with clay and boulders, 1 mile through rock, $1\frac{1}{2}$ miles, loamy farm-

land and the remaining $4\frac{1}{2}$ miles, shale.

Owing to the limited time to complete the work, excavation, which started at the dam, was begun in January, 1912, in order to have a large amount of trench ready for the pipe-laying in the spring. As the winter was unusually severe and considerable frost was in the ground, it was found necessary to open the trench with the aid of dynamite. It was tried for the first 2 miles through the gravel and boulder section. Holes were driven to the required depth of trench, about 6 ft. apart, and charged with $1\frac{1}{4}$ -in. sticks of 40-per cent nitroglycerin dynamite, one on top of the other to within about a foot of the top of the hole. About fifty holes were fired at once. Several different experiments were tried as to depth and arrangement and spacing of holes and quantity of dynamite, but the



CONSTRUCTION PLANT AND QUARRY AT SITE OF DAM FOR CUMBERLAND WATER SUPPLY

above-mentioned combination was the most successful. Approximately one-third of the excavation would be blown out in this process and the remainder loosened up so that it was comparatively easy to remove with shovels. The method seemed a success until spring, when the frost came out and the banks crumbled and caved in to such an extent that a gang had to be sent back to clean out ahead of the pipe-laying gangs. This considerably added to the expense, and it would no doubt have been more successful and cheaper, had time permitted, to wait until spring before beginning the excavation.

The contractor was the Merrill-Ruckgaber Company, of New York. The work was designed and directed by James H. Fuertes, consulting engineer, of New York, represented on the work by J. C. Shriver and R. R. Fernow, resident engineers.

MATHEMATICAL LABORATORY is the name of a new course introduced at the Massachusetts Institute of Technology by Dr. Joseph Lipka. The course includes the most modern methods of numerical, graphical and mechanical calculations, with particular emphasis on their relations to engineering and applied mechanics. Various applications of arithmetic and algebraic processes as well as those of calculus are taken up. The making of graphical charts and the study of computing instruments are also included in the course.

Iowa State Highway Bridges Not Too Heavy

Investigations Show Greater Cost on County Built Roads than under Present Regime, Despite Insufficient Concrete for Safety

“ARE the bridges and culverts designed by the Iowa State Highway Commission too heavy?” is a question raised by the taxpayers in Iowa. This question embodies a criticism of State control, which not so very long ago replaced county control and created a new era of bridge building in the State. To ascertain whether or not this criticism is justified the commission has carried out an investigation covering eighty-two bridges and culverts. This investigation, which was conducted last year and included a detailed inspection,

mathematical analysis and field study of the behavior of the structures, naturally resolved itself into two phases—a comparison of the utility and a comparison of the cost of bridges built under State control with those formerly built. The results of this investigation have been set forth recently in an article in the “Service Bulletin” of the Iowa State Highway Commission by C. B. McCullough, from which the following has been taken.

DEFECTS OF DESIGN OF OLD BRIDGES

Of the eighty-two of the lighter-sectioned bridges examined, all built under county control, sixty have clearly developed defects. Sixteen are sufficiently defective to be unsafe for traffic, particularly through any period of continued high water. Two are in a state of complete collapse.

The causes to which the defective and unsafe condition of these spans may be attributed are insufficient foundation areas, or depths, or both, noted in thirty-nine cases; inadequate reinforcing, noted in sixteen cases; insufficient dimensions of sections, noted in seven cases; “thin-section” concrete members placed in positions exposed to frost upheaval and stream erosion, noted in thirty cases; inadequate wing-wall lengths, allowing stream erosion behind the fill, noted in eight cases; inferior materials and workmanship, noted in eight cases.

Of these eighty-two structures twenty-eight have had, and seventeen more are in

immediate need of, repairs or renewals. The causes to which this lack of permanency may be attributed are "thin-section" concrete members placed in positions exposed to upheaval and erosion noted in twenty-eight cases; insufficient foundation depths, noted in fifteen cases; the use, to save first cost, of wing walls insufficient in length to retain properly the earth approach filling, and which have after construction been lengthened by bulkheads of timber or riprap, noted in twenty-three cases.

INSUFFICIENT FOUNDATIONS AND WATERWAYS

In 65 per cent of the defective spans such defects may be traced entirely or in part to insufficient foundation depths or areas or both. The majority of the structures examined had foundations not exceeding 2 ft. below stream bed and in many cases less than this. The State specifications call for a minimum foundation depth of 4 ft. below stream bed, and piling is required if there is any question of the character of the foundation material. The foundation pressures on many of the structures examined, as determined by accurate mathematical analysis, reach the unsafe limits of 8 or 9 tons per square foot on clay soils. The State specification limits such loading to 2 tons per square foot maximum on such soil.

In 26.6 per cent of the defective spans insufficient dimension of sections under stress was a contributory cause of the defects. Analysis according to the best practice of the internal stresses produced by ordinary load conditions discloses a stressed condition in the defective spans of from 40 to 80 per cent in excess of the units adopted by the State as a maximum. The excess material used under the State specification has been a direct attempt to overcome the defects found in the lighter type of construction. In the light of the examination, which covered practically every bridge in each county taken up, so that there might be no charge that special bridges were selected for the study and comparison, it would certainly appear that the excess material required by the State standard over the lighter-sectioned type is not only warranted but absolutely essential.

INVESTIGATION OF COSTS

The second step in the investigation pertained to a cost comparison wherein unit prices fixed by completion at public, advertised lettings are compared with the unit costs dependent upon private agreement between the contractor and the public officials. The bridge purchaser, the public, is interested in knowing to what degree the reduction in unit costs due to free and open competition operates to offset the cost of the extra material used under the State standards. The public wants to know the relative cost of the two types of construction.

During the investigation of the bridges built under county control, data were secured establishing the contract cost of practically all of the structures examined. While the yardage cost based on quantities computed from such of the plans as were found on file ran considerably in excess of the average yardage cost for the past year under State control, this fact alone does not establish the economy of the State-control bridge, inasmuch as the yardage for a given waterway is usually considerably greater for this latter type of construction. The comparison must be carried further than mere yardage

of material and must be based on the measure of service rendered by each structure, which can be based on but one consideration, namely, waterway carrying capacity.

Manifestly even this comparison fails if the structures compared are of different roadway widths, and to obviate this difficulty all costs were prorated to a clear roadway width of 16 ft. The total aggregate waterway for the bridges examined, all built under county control, is 14,571 sq. ft. and the total prorated cost for a standard clear roadway width of 16 ft. is \$78,444.72. Under county control, therefore, the results of the investigation disclose the fact that for concrete bridge construction of standard 16-ft. clear roadway width for every square foot of waterway the taxpayers of the county were taxed \$5.38.

HEAVIER STATE BRIDGES ARE CHEAPER

These data for all the 1914 concrete bridge structures designed by the State Highway Commission for which contracts had been approved and cost data were available disclose the fact that under State control concrete bridge construction of

standard 16-ft. clear roadway width each square foot of waterway has cost the taxpayers of the counties of the State \$3.93. The logical deduction from this comparison, states the bulletin, is that the reduction in unit cost due to competitive bidding and advertised lettings not only completely offsets the cost of extra material required by the State standards, but results in an additional economy.

The Highway Commission is convinced that the bridges and culverts designed under the State standard specifications are not too massive. It believes that the extra expenditure required by these designs is not only warranted but absolutely essential to safety and permanency. There is evidence that under publicity and competitive bidding methods there is a definite first-cost economy in favor of the heavier bridges where compared with the lighter structures as actually built. There is the further self-evident assurance that the standard-plan bridges and culverts carry far greater factors of safety and permanency, the only grounds on which to justify concrete bridge and culvert building.

Compensation of Engineers Varies Widely— Those in Contracting Fare Best

American Society Committee Presents New Curve of Middle Men, and
Classifies the Engineers as to Work, Location and Technical Education

NEW STATISTICS presented last week at the annual meeting of the American Society of Civil Engineers by the special committee appointed to investigate the conditions of employment and compensation of engineers tend to support the figures submitted by the committee in the first progress report made a year ago. The main feature of the earlier report, which was abstracted in the Engineering Record of Jan. 24, 1914, page 105, was a diagram showing the maximum, minimum and average yearly compensation of 3638 members of the society divided into groups according to their years of experience.

The new report includes the replies from 1158 additional members, which modify to some extent the curves originally presented. New minimum figures are shown in a number of cases. There are also several new maximum figures, although the maximum curve still zigzags violently. The average curve does not differ greatly from that shown last year; for the first fifteen years it is somewhat lower and smoother. After the fifteenth year it still fluctuates with the maximum curve in a way suggesting the need of records from more men. A feature of the new diagram is a fourth curve, of the middle men of each group. This is considerably under the average curve. A second diagram groups the men according to the nature of their work and indicates that contractors fare best and consulting engineers next best, and that employees of States and counties fare the worst. In a third diagram, in which the men are grouped geographically, perhaps the most noticeable feature is the decided disadvantage of the Southern men after the twenty-fifth year. The New England men receive the least in the earlier years. Otherwise, except that the men in foreign countries are paid better throughout, the curves deviate little up to the twenty-fifth year, when those for the Middle Atlantic and

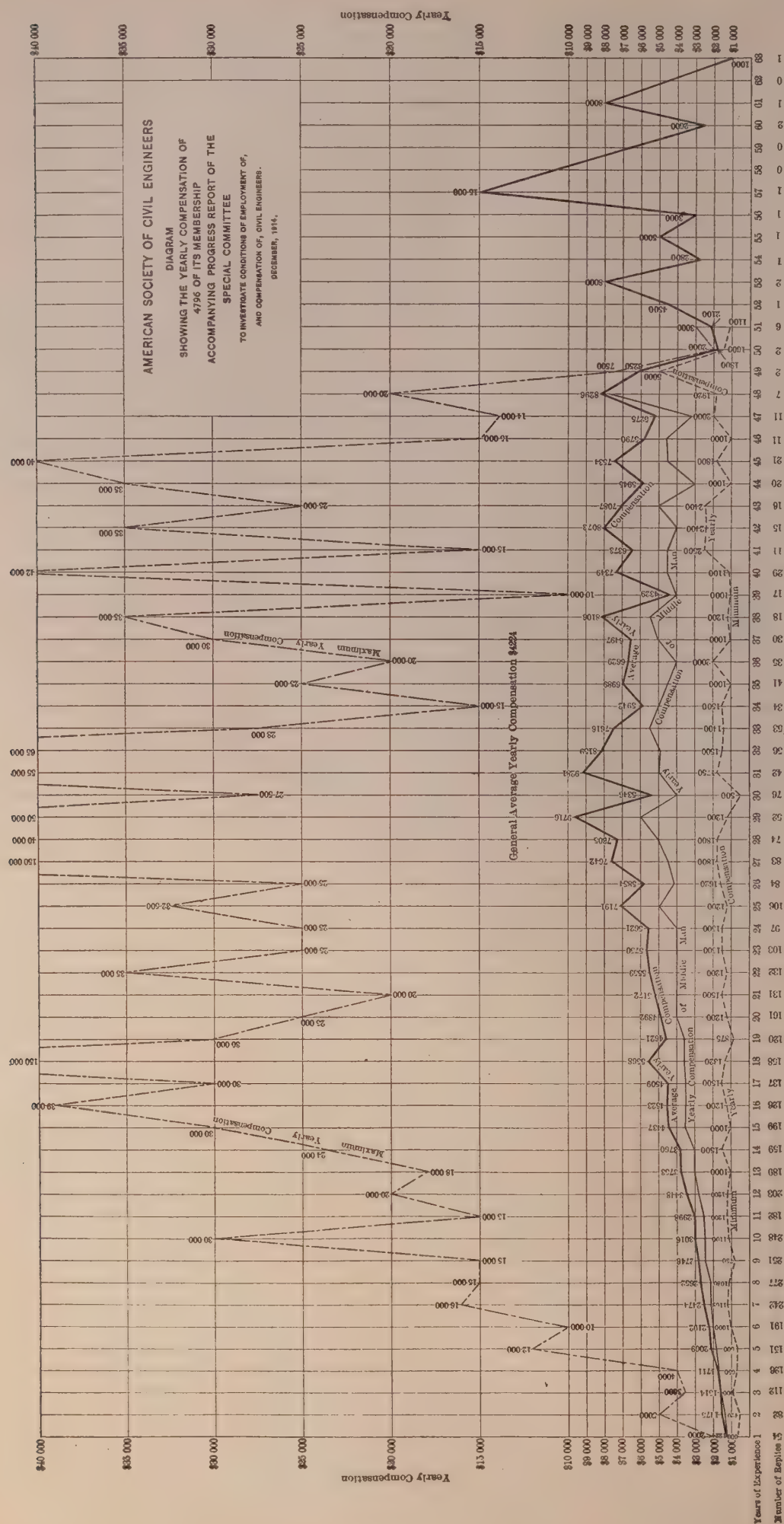
Central groups rise away from the others. The fourth diagram compares graduates and non-graduates, and shows a decided advantage for the former after the fifteenth year.

The report is signed by Nelson P. Lewis, John A. Bense, S. L. F. Deyo, Dugald C. Jackson, William V. Judson, C. F. Loweth and George W. Tillson. The substance of the report follows.

MAXIMUM, MINIMUM, AVERAGE AND MIDDLE MEN

The methods described in the first report for securing the information have been continued, but an effort has been made to reach a larger proportion of the membership of the society. The earlier report was based on information received from 3638 members in various grades. On May 22, 1914, a second circular was sent out, to which 1240 replies were received; of these, 1158 gave information which could be availed of, bringing the total number of usable replies up to 4796, which was two-thirds of the entire membership of the society when the second circular was mailed. The information has been carefully analyzed and incorporated in the large diagram similar to that used in the first report, and the new curves, while corresponding quite closely with those already published, are naturally more uniform and are believed to be more representative.

The irregularities in the curve representing the average yearly compensation have been generally reduced, although at some points they have been emphasized. For instance, although returns from engineers having 29 years of professional experience have been increased from 44 to 52, and although the maximum and minimum compensation remain the same, the eight additional replies have raised the average from \$9,315 to \$9,716, while at the next point on this curve, represent-



ing 30 years of active experience, although the maximum remains the same, there is a new minimum of \$500, yet the average compensation has been increased from \$5281 to \$5346. Again, at 38 years, a new maximum, \$10,000 greater than that formerly reported, has, with the same minimum, raised the average from \$6746 to \$8106; while at 39 years, where the maximum was and is \$10,000, and the minimum \$1000, five additional replies have decreased the average from \$4600 to \$4329.

In the first report reference was made to an attempt to draw a curve representing the compensation received by the middle man, but such a curve was not included in the diagram. Such a curve has been included in the diagram now submitted, and the committee considers it worthy of special study.

CONTRACTORS ARE PAID BEST

Believing that the variation of compensation with the character of employment should be shown, Fig. 1 has been prepared indicating the average compensation paid by the National Government, States, municipalities, technical schools, railroads, and private corporations and companies, as well as the incomes of consulting engineers and engineering contractors. Inasmuch as the number of replies for each year of experience was relatively small, and might therefore be misleading, they have been grouped in 5-year periods, and the resulting curves are believed to be of interest and value. They indicate that the salaries paid by the National Government, States, cities and technical schools, including in the last receipts from private practice, while closely corresponding with those paid by railroad companies during the first 20 years, are materially less after that period; that other corporations and private companies pay considerably higher salaries, and that the largest incomes are those of consulting and contracting engineers. That the curve showing the incomes of contracting engineers reaches its highest point at 30 years is probably due to the fact that it is only about 30 years ago that engineers became contractors to any considerable extent, or possibly to the fact that their success enables them to retire from active work at a relatively early age.

LOW PAY IN SOUTHERN STATES

Fig. 2 shows the compensation received, arranged in geographical groups, using five different sections of the United States and placing the members of the society who are engaged in engineering work in foreign countries in a separate group, this diagram also being based on the average for 5-year periods. The results are so obvious that they call for no comment.

GRADUATES AND NON-GRADUATES

The committee also submits Fig. 3, showing the relative compensa-

Years of experience	Average age of graduates	Average age of non-graduates
2	24.8	27.4
3	25.7	25.3
4	27.2	25.6
5	28.4	27.7
6	29.2	27.8
7	30.1	29.9
8	31.2	29.8
9	31.9	31.0
10	32.9	32.3
11	33.6	33.2
12	34.4	34.8
13	35.6	35.7
14	36.6	35.8
15	38.0	37.5

tion received by engineers who are graduates of technical schools and those who are not. This diagram is of special interest owing to the fact that the curves for graduates and non-graduates follow each other very closely for the first 15 years. The graduate engineer appears to have an advantage from that time on to about 45 years, when the curves again come together.

The average yearly compensation of 1998 graduates having an experience of from 2 to 15 years is \$2756. The average yearly compensation of 614 non-graduates having an experience of the same length is \$3154. The average yearly compensation of 1394 graduates having an experience of from 16 to 50 years is \$6328. The average yearly compensation of 719 non-graduates having an experience of the same length is \$5359. This may be due to the fact that the preparation of the graduate engineers represented by that part of the curve between the fifteenth and forty-fifth years was more thorough in the fundamentals of engineering education, and that, whatever may have been their compensation in comparison with that of non-graduates for the first 15 years of their professional life, this thoroughness

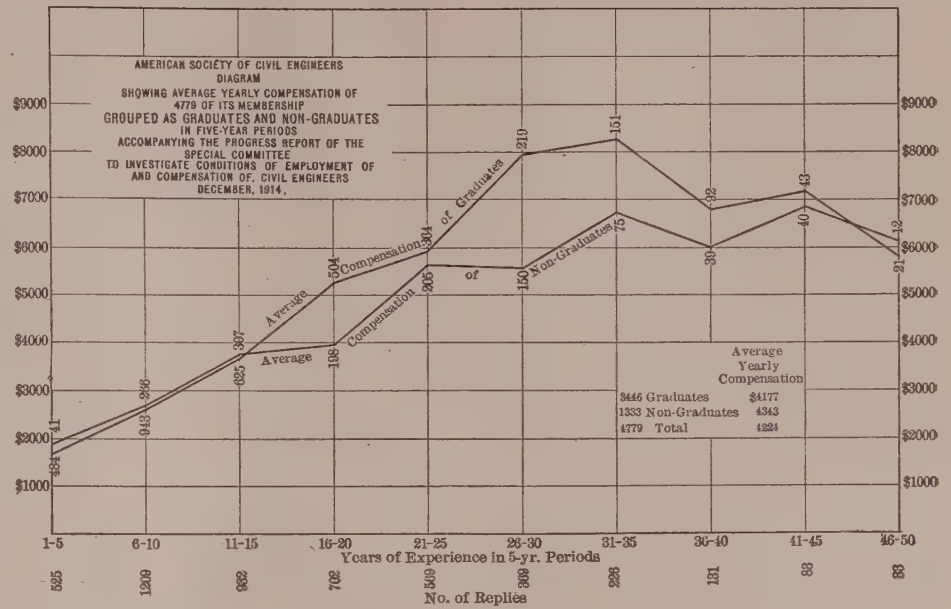


FIG. 3.

of preparation shows its effect from that time onward. It may be that among the non-graduates of technical schools only the most ambitious men apply for membership in the society.

Thinking that the non-graduate members of the society might be older men, the committee has requested the Secretary to furnish it with figures showing the ages of the graduate and non-graduate engineers whose returns supplied the data for the first 15 years of the curve. These are shown in the accompanying table. It appears from these figures (which begin at the second year for the reason that non-graduates are not eligible for the grade of junior for the first year of their experi-

ence) that the average age of the non-graduates is slightly less, instead of greater, than that of the graduates.

The replies from engineers having more than 50 years of experience are so few, and the information given by them is of so little significance, that it has not been included in any of the diagrams except that giving all the returns without classification.

ANSWERS TO COMMENTS ON FIRST REPORT

In the discussion of the committee's first report the opinion was expressed that if curves had been prepared which excluded the upper and lower 5 per cent, and the upper and the lower 10 per cent, the result would have been more nearly representative

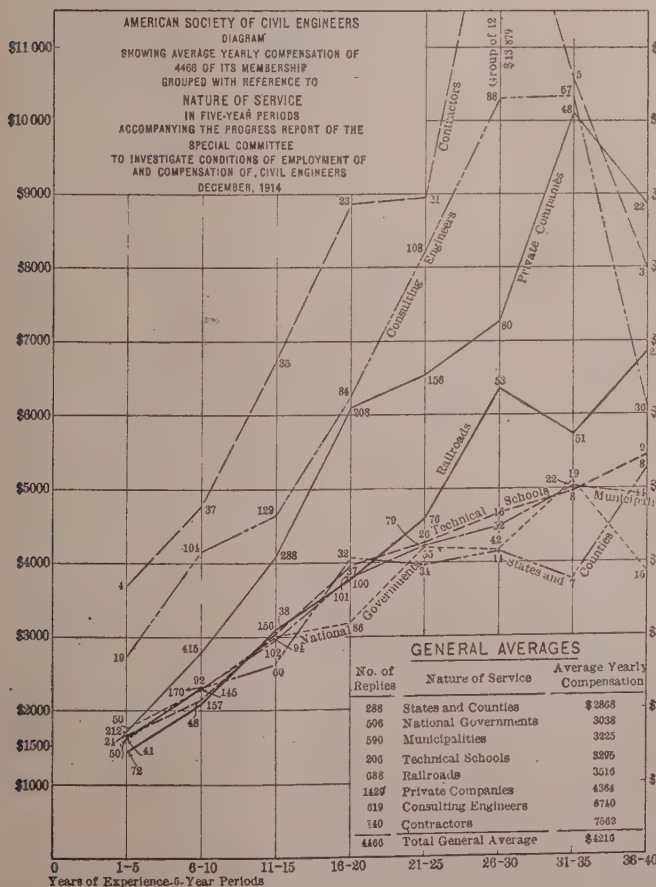


FIG. 1.

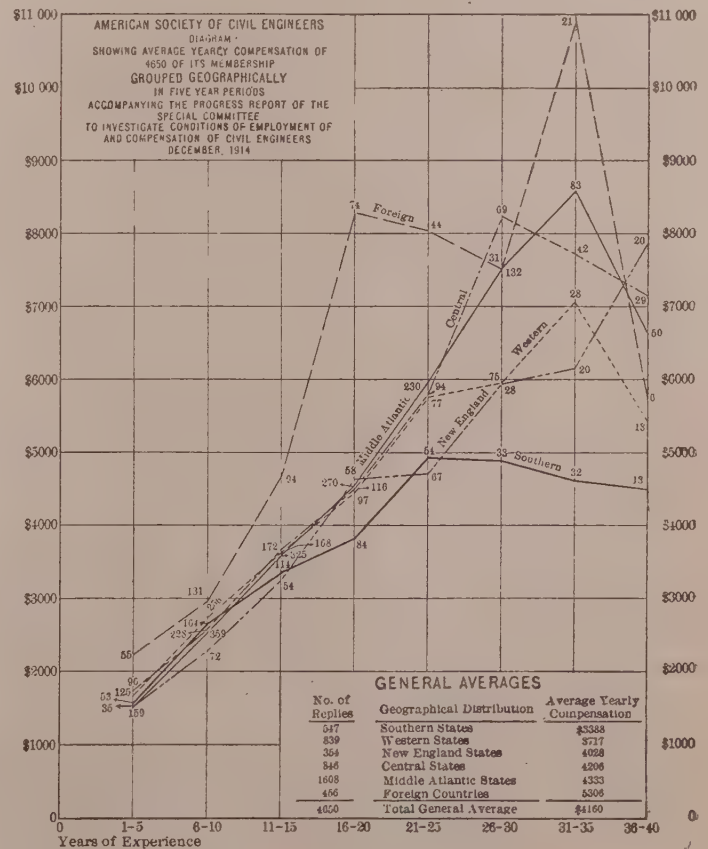


FIG. 2.

of the average compensation of civil engineers. It is doubtless true that the curves would have been more regular and somewhat lower, but the committee believes that it should take account of the clearly exceptional man as well as of the average man. It was also stated that if those who failed to respond had been heard from the averages would have been materially lower. This opinion does not appear to have been confirmed by the 1158 replies to the second circular, which have made little change in the curve, except to render it somewhat more uniform.

Another suggestion was that if all professional incomes of more than \$15,000 a year had been excluded, the result would have more nearly represented actual conditions, but the committee believes that this would have been distinctly unfair and misleading.

The majority of those who contributed to the discussion expressed the belief that the statistics should include all engineers who could be reached, and should not be confined to members of the society, and that the curves given represent a select list and the ideal rather than the real compensation received by engineers, one of the reasons for this being that members of the society who receive very small salaries are sensitive about making a return. The committee believes, however, that in a canvass of the entire engineering profession there would have been the same reluctance of low-salaried and unsuccessful men to answer the questions.

TO INCLUDE NON-MEMBERS OF THE SOCIETY

The committee believes that the society is the representative body of civil engineers in this country and that information collected from its members is the kind of information that the members of the society wish. In order, however, to meet the evident desire of many members of the society for statistics which will include those outside its membership, the committee proposes to endeavor to secure such information and to make a further classification based on actual age as well as the number of years in engineering practice, while it is also proposed to secure information indicating the proportion of time engineers are out of employment. In securing information concerning engineers who are not members of the society, the committee will be obliged to use such data as it can secure from railroads, municipalities, and other organizations or individuals employing engineers, and from technical schools which have compiled statistics concerning their graduates and former students. The committee realizes that the collection of this kind of data will be much more difficult than the work which it has already done and that the results will be less conclusive and less accurate than those herewith presented. If it is the pleasure of the society to continue the committee for another year, this work will be undertaken, and, in this event, the committee hopes that members of the society will voluntarily send to it any information they may have which will be of assistance in this work, or that such data be presented in the form of discussions of this report.

THE UNITED STATES FOREST SERVICE is co-operating with fifty-four railroads, mining companies, pole companies and cities in making tests of wooden ties, timbers, poles, piling and paving blocks which have been given preservative treatments.

Eleven-Span Wooden Arch Bridge of Fifty Years Ago

Built for Military Purposes During the Civil War
Without the Use of Iron—Washed Away
Three Years After Its Completion

A WOODEN arch bridge, more than 1000 ft. long between abutments, was built over the Tennessee River at the foot of Market Street in Chattanooga, Tenn., during the Civil War. Since contracts have recently been let for the construction of a very large, modern, reinforced-concrete bridge at this site, a description of the first bridge erected there is of historical interest.

The old bridge was built for military purposes in 1864 by Montgomery C. Meigs, quartermaster-general of the Federal army, to prevent General Sherman's army from being bottled up in Chattanooga, as had happened to the army of General Rosecrans the year previous. General Meigs, who had

90-ft. double-leaf bascule span, ending in timber trestle approaches on each side of the river leading to high ground.

NO IRON EXCEPT FOR DOWELS

The most remarkable structural feature of this bridge was that no iron or steel was used, except drift bolts or dowels used to hold in place the guard rails, flooring, etc. After the main timbers had been sawed they were steamed, bent, placed in the arches and fastened together with wooden pins. The floor was about 40 ft. wide and was laid directly on the superstructure of the arches, held in place by timber guard rails fastened by dowels.

The leaves of the 90-ft. bascule span were operated by block and tackle from two gallows-frames erected on adjacent piers. Four hand-driven steamboat capstans on the floor of the bridge served as hoisting machinery.

The piers were built of round timbers



THIS WOODEN BRIDGE COST \$750,000 AND LASTED THREE YEARS

also been connected with the construction of the famous Cabin John masonry bridge at Washington, built the original Market Street bridge at Chattanooga, of green timber, cut and sawed on the hills where Hill City now stands.

The accompanying illustration, made from a photograph taken shortly after the bridge had been completed, shows the general type of construction employed, and the camp of the garrison defending the block-house fortifications at the north approach, shown in their immediate foreground. The long, low commissary sheds or provision houses of the Federal army are shown on the Chattanooga or southern side of the river, beyond which can be seen the hospital tents and guard camps extending to the summit of Cameron Hill on the right, and Lookout Mountain in the background, on both of which fortifications are visible. The wooden arches, each of 90 ft. clear span, were supported on stone-filled crib piers and wooden bents, and at the south end of the structure a 90-ft. double-leaf bascule was provided for navigation.

ERECTION

Beginning at the north bank the first pier, which acted as an abutment, stood at the water's edge. Three spans were constructed, supported on two intermediate bents and the second pier; then four spans were placed connecting three intermediate bents and the third pier, and then three similar spans to the fourth abutment pier. The bascule span bridged the gap between the fourth and fifth piers, thus completing the structure from shore to shore. On both sides of the river the approaches consisted of wooden trestles. It will therefore be seen that the complete bridge consisted of ten 90-ft. timber arches, five stone-filled crib piers, seven intermediate bents, and a

dovetailed together and forming a cutwater on their upstream ends. Both piers and bents were sheathed with 4 x 12-in. planks so as to prevent driftwood from catching. The bents were held to the bottom of the river by cross timbers weighted down with stone. The spikes used to fasten the sheeting, the hub guard and side railings on the floor of the bridge, the strap hinges and a few other pieces used on the draw span constituted the only iron used in the construction.

HIGH COST AND SHORT LIFE

The bridge was called "Meigs's Folly," after its builder, because of its enormous cost of \$750,000. It is stated that common labor was paid from \$3.50 to \$4 per day, and skilled labor from \$5 to \$7.50.

When the war was over the bridge was given to the city. As the timber, however, had begun to decay, the expense of keeping it in repair was large. One day a large drove of mules became frightened, and as they stampeded over the draw span, the rotting ropes, which held the leaves, broke and about forty of the mules fell into the water and were drowned. The city had to pay damages.

In the spring of 1867 the greatest flood that had ever taken place in the river at that point washed out the structure. This flood rose rapidly to a height of 58 ft. above low-water level and lodged driftwood, haystacks and the remains of bridges and houses against the bridge piers. When the water reached the superstructure and began to flow across the floor the accumulated drift exerted such a pressure that the bridge gave way.

The Engineering Record is indebted to B. H. Davis, consulting engineer, New York City, for the notes and the photograph used for this article.

Co-operative Road Administration Plan Aided by Post Card Bulletins

Leading Citizens Head Branches of Spokane County Association and Overseers Receive Terse Instructions by Mail from Headquarters

By LeROY W. ALLISON

BY selecting leading citizens as heads of district branches and issuing terse instructions to road overseers through the medium of postal cards the Spokane County Good Roads Association, of Washington, has achieved notable results in carrying into effect a co-operative plan of road administration which has increased the mileage of improved roads from 5½ in 1910 to 119 in 1915.

A NOVEL ENTERPRISE

As an organization devoted to road betterment work, the Spokane County Good Roads Association represents a novel and interesting enterprise of more than local scope, for its influence is extending throughout eastern Washington and into parts of Idaho and Montana. Each incorporated municipality of the immediate county now maintains a direct branch of the association to carry out its work in local territory, under the direction of a vice-president appointed from the local membership by the parent organization. This vice-president is selected from the leading citizens of each respective community and is the official head through which the Association derives concerted action and support in establishing and maintaining beneficial policies. Each particular branch elects its own secretary-treasurer.

A regular feature of the association's general activities has been an annual convention at Spokane for road overseers and supervisors, at which are discussed topics of general interest and individual local problems. At the last convention about 150 of these road-builders were present, enthusiastic in their commendations of the knowledge and results derived.

ROAD MAINTENANCE

The association has devoted considerable effort to the subject of proper and adequate road maintenance. Particular difficulty has here been evidenced, as elsewhere, in bringing road officials to an appreciation of the fact that the completion of a road is in reality the commencement of their responsibility. This has also been found in advancing the use of the split-log drag for grading, from which excellent results have been obtained. It has been hard to impress the road overseers and farmers with the necessity and importance of dragging the roads at the proper season, or just as the surface commences to dry out. At such a time they can be dragged with the least possible labor and greatest ultimate effectiveness.

500 ROAD DRAGS

When the association inaugurated its movement among the road overseers and supervisors for utmost co-operation in dragging for earth road maintenance, about 12 drags of various types were in service in the immediate territory. There are now over 500 road drags tributary to Spokane alone. For the most part they are efficiently operated during the spring and fall months. The particular advantage of dragging reverts to the drainage of the road and consequent preservation. The road being thus

properly smoothed with a fairly uniform slope, permits of rapid drying during rainy periods and eliminates breakage of the compacted traveled surface. In Spokane County, the continued use of the split-log drag has resulted in fine county highways

March 27, 1914.

DEAR SIR:

You have done well! More miles of earth roads have been put in fine shape by use of the split-log drag this spring than in all times past.

Do not use the drag when the road surface is dry.

Just as the surface begins to dry out is the time.

FRANK W. GUILBERT, Sec'y.,
Spokane County Good Roads Association.

Please try to drag the roads in your jurisdiction twice more before the 4th of July.

Do not drag the roads unless they have a good soaking, then *just as the surface begins to dry out.*

Never drag a dry road. Your road should be crowned at least a little before you can get first-class results by the use of the drag.

SPOKANE COUNTY GOOD ROADS
ASSOCIATION.

I want to thank the many supervisors and overseers who have used the drag this spring and shown what fine results can be obtained through its use.

FRANK W. GUILBERT, Secretary.

If you will drag your roads three times between now and winter, two round trips each time, you will have better roads all winter and less mud in the spring.

The taxpayers in your district are entitled to this small expenditure.

SPOKANE COUNTY GOOD ROADS
ASSOCIATION.

When your road gets too high in the middle use your split-log drag, both going and coming, the first round trip on the high part of the road. Please remove all loose stones from the roads in your district.

When you grade the roads and move some sod or other vegetable matter into the traveled portion of your road be sure and REMOVE IT BEFORE THE ROAD BECOMES PACKED, or else you are bound to have a mudhole there in the spring and fall, or a dusthole during the summer. This is a mistake that most road overseers make. They feel that after the sod is once covered no bad results will follow, but the dead organic matter is bound to keep working under traffic, whether on the surface or under the surface, and make a mudhole or a dusthole.

When your grade is completed, a LEVEL LINE across and touching the center of the road should be exactly the same height above either edge of your road.

The best crown for an average dirt road should be one inch in one foot. If your road is graded twenty-four (24) feet wide, the center of your road should be twelve (12) inches higher than the edges of your road.

SPOKANE COUNTY GOOD ROADS
ASSOCIATION.

THE OVERSEER'S INTEREST IN HIS WORK IS STIMULATED BY FREQUENT POST CARDS FROM HEADQUARTERS

during the dragging season, and less dusty and muddy highways through intervening periods.

POST CARD BULLETINS

To inform road overseers constantly of the essential factors in the upkeep of the country roads at a minimum cost, the association has devised an interesting series of bulletins in the form of post cards. These,

setting forth terse and important instructions, have been issued at the opportune season and widely distributed with gratifying attention and results. Additionally, indirect benefits have been evidenced through this circularizing in making the Spokane office of the association a natural clearing-house for advice and help in the different communities. The road supervisors and overseers, in making the association office their headquarters when in the city, are brought into closer contact with the organization work, with resulting increased interest.

For the greater part these post-card bulletins are of standard size, 3¼ x 5½ in. The accompanying set-up gives examples of their contents. Others are larger, about 5½ x 11 in., mailable under one-cent postage, and carry more specific information.

ROAD CONSTRUCTION

In the construction of its roads, and in which the association has taken an active part, Spokane County has employed extensively the oil-bound macadam type of surfacing by the penetration system. Of such roadways about 19½ mi. have been completed, and 13½ mi. are now being constructed. The association has given particular attention to the adoption of suitable standards for common dirt or earth roads; these gravel highways, of which there are now about 35 mi. fully improved, are considered with special favor, owing to the initial cost of installation, and the subsequent low cost of maintenance. Other classes of roads used are water-bound macadam, 10 mi.; asphaltic concrete, not patented, 1½ mi.; and Warrenite, 1.37 mi.

In addition to its participation in these county highway improvements, the Spokane County Good Roads Association has been largely instrumental for the concentration of State road expenditures in Eastern Washington, totaling about \$600,000. Co-operating with the Spokane City Chamber of Commerce, the association has been responsible for the construction of a continuous hard surfaced trunk highway east and west from county line to county line, and forming an arterial connection with the county's improved roads.

SECRETARY GUILBERT'S COMMENT

In commenting upon the work of the Spokane County Good Roads Association to the writer, Frank W. Guilbert, its secretary, to whom credit is due for data noted herein, said:

"I believe our success has been due to the fact that before we make any demands we are sure we are right, and then we are willing to fight for our position to establish it. I am confident that the taxpayers appreciate the fact that we are guarding their interests. Another thing which has tended to our success has been that we try to keep better posted on laws of all kinds and methods of construction work than the road officials themselves. We are really an organization which makes a business of road promotion and development work, composed of fair-minded business men who are willing to give some of their time to consideration of these problems."

WROUGHT-IRON AND STEEL PIPE and boiler tubes to the extent of approximately 2,245,532 gross tons were produced in the United States during 1913, according to a bulletin issued by the American Iron and Steel Institute.

American Wood Preservers' Association

Abstracts of Additional Papers Presented at the Eleventh Annual Convention
at Chicago, January 19, 20 and 21 — Preservatives and Plant Operation

Toxicity of Coal-Tar Creosote for the Xylotrya

By L. F. SHACKELL, M. D.
Assistant Professor of Pharmacology, St. Louis
University School of Medicine

TESTS undertaken some time ago by the Forest Products Laboratory to determine the relative efficiency of various constituents of coal-tar creosote against marine borers were discussed by C. H. Teesdale in the Engineering Record of Sept. 12, 1914, page 302. As an outgrowth of these investigations experiments were carried on at the Marine Biological Station of the U. S. Bureau of Fisheries at Beaufort, N. C., to determine the comparative toxicity of creosote, creosote distillates, and their individual constituents on the xylotrya gouldi that infests the waters around Beaufort. Conclusions reached to date are as follows:

1. The toxicity of creosote fractions diminishes with rise of boiling point; the toxicity of creosote itself lies between that of the lowest and highest boiling fraction.
2. The loss of volatile constituents reduces the toxicity of creosote and of its fractions.
3. The light oils of creosote are very toxic even in the extremely slight proportions in which they are soluble in seawater.
4. Naphthalene and anthracene are practically non-toxic for xylotrya.
5. The tar acids are extremely toxic for xylotrya, alphanaphthol being many times more poisonous than phenol.

A Specification for a Coal Tar-Creosote Solution

By Dr. HERMANN VON SCHRENK and
ALFRED L. KAMMERER

LAST YEAR we presented the results of some tests made with mixtures of refined coal tar and creosote, which indicated that when such mixtures consisted of about 20 per cent coal tar and 80 per cent creosote, an oil was produced which could be successfully used for the impregnation of ties. It was found that such an oil penetrated timber to the same extent as the usual heavy creosote oils, provided the mixture or solution was kept at about 180 deg. Fahr. It was recommended that the mixture be made at the treating plants.

During the past year it has become somewhat difficult to obtain the usual supply of high-grade foreign creosotes, and there have been increased inquiries for the mixture of coal tar and creosote. It was suggested that the solution of the two substances could be more readily achieved at the plants where the creosote was made than at the treating plants, because it was easier to filter the mixture and thereby reduce the carbon percentage. This brought up the question whether a specification for the finished product could be written, so as to make it possible for a prospective consumer to buy the mixed oil in completed form.

In co-operation with the Barrett Manufacturing Company a number of tests were made by the writers to determine distilling points, specific gravities and viscosities of various mixtures. Several coal tars were selected and these were mixed in different proportions with various light creosote oils. Based on these determinations a specification was written, which follows herewith:

The oil shall be a pure coal-tar product, consisting only of coal-tar distillates and oils obtained by the filtration of coal tar. It shall contain no admixture of crude tar. Water shall not exceed 2 per cent. Specific gravity at 38 deg. C. shall not be less than 1.06 or more than 1.10. Matter insoluble on hot extraction with benzol shall not exceed 2 per cent. Viscosity (Engler) at 82.3 deg. C. (180 deg. Fahr.) shall not be more than 59 for 200 cu. cm. No variation above 59 seconds shall be allowed. On distillation by the standard method of the American Railway Engineering Association it shall yield the following fractions, based on dry oil: Not more than 1 per cent at 170 deg. C.; not more than 5 per cent at 210 deg. C.; not more than 30 per cent at 235 deg. C. The residue at 355 deg. C. shall not exceed 26 per cent.

NOT A FINAL SPECIFICATION

In presenting this specification it should be understood that we regard it as by no means final. It is a frank attempt to describe in as few words as possible an oil made up of coal-tar creosote, with a certain percentage of coal tar. The writers have had occasion to examine a number of samples purchased under this specification, and found that they came within the prescribed limits. The justification for such a specification lies in the fact that a mixture of the two substances was being prepared for general use and sold in large quantities. This has previously passed more or less as creosote oil. The present specification states in so many words that a mixture is contemplated. It is hoped that the writing of this specification will bring forth suggestions as to improvements.

FRANKNESS INSTEAD OF MYSTERY

In this connection it should be pointed out that a largely increased consumption of creosote and an increased application of creosoted materials will depend very largely on the confidence which a purchaser will have in getting the product which he is paying for. There has probably been justified criticism because of practices in connection with creosote in the dim and distant past, sometimes referred to as the day when anything which looked black and smelled bad passed any specification for creosote oil. We all know that excellent results have been obtained by the use of creosote conforming to all kinds of specifications. All the oils, however, which have given good results have been coal-tar oils. The fact that they differed widely in some respects has resulted in the omission of apparently unimportant requirements in our modern specifications, such as percentages of tar acids,

flash point, etc., and has tended to simplify the specifications. There is nothing about the industry which is not capable of rigid examination. It should remain so, however. The recent increased admixture of water-gas tar with creosote is hardly to be regarded as a step in advance. If water-gas tar is worth anything at all, why not state frankly that it is being used? The same course is apparently being followed with this substance as was the case with the coal-tar addition. Let us use every effort to stimulate the use of whatever preservative is used under its own colors. It is a hopeful sign that the day is not far distant when creosote distilling plants will sell their product subject to inspection as it comes from the stills. In the minds of many consumers there has been too much connected with this industry which has been mysterious. There is no reason for this, and there ought to be none. We offer the specification for a coal tar-creosote solution as a step toward a better understanding of one phase of the industry.

Temperature Changes in Wood Under Treatment

By GEORGE M. HUNT
Chemist in Forest Products, Forest Products
Laboratory, Madison, Wis.

THE subject of heat conductivity in wood has a practical bearing on all pressure wood-preserving processes, and it is to be regretted that it has been so little studied. In the treatment of ties and other timbers where steaming is resorted to it is important to know how rapidly the heat penetrates to the interior of the stick, or how long an exposure is necessary to bring the temperature of the interior up to the boiling point of water. This knowledge is necessary in order to gauge economically the time employed in steaming processes, and is also important in applying creosote by the boiling process.

As a part of the work of the Forest Products Laboratory experiments have been made on sawed maple, red oak, loblolly pine and hemlock ties, both green and seasoned. Four hemlock ties and nine of each of the other species were shown. The results of the experiments may be summarized as follows:

1. In most of the ties there was no appreciable rise in interior temperature during the first 30 or 40 min.
2. The interior of the ties never quite attained the temperature of the heating medium.
3. In the treatments with steam at 20 lb. pressure the time required for the interior to reach 212 deg. Fahr. varied from $2\frac{3}{4}$ to 5 hr., the average being 4 hr. and 20 min.
4. Upon the application of the vacuum the interior temperature fell very rapidly.
5. The rate of increase of interior temperature was greatest in the treatments with steam at 20 lb. pressure, and least with creosote at 185 deg. Fahr.
6. The rate of increase of interior tem-

perature was slightly greater in the treatments with steam at 212 deg. Fahr. than with creosote at the same temperature, at zero gage pressure.

7. Seasoned ties heated more rapidly than green ties.

8. No appreciable difference in the rate of increase of interior temperature due to difference in species could be determined.

9. In the steam and vacuum treatments green ties always showed a loss of moisture, while seasoned ties sometimes showed a gain and sometimes a loss.

10. Practically all the ties continued to lose weight during the first 24 hr. after treatment. Creosoted ties lost less weight during this period than steamed ties.

11. In the treatments with steam at 20 lb. pressure, the green ties were badly checked while seasoned ties were not so seriously affected. In the other treatments, none of the ties were seriously checked.

How Not to Waste Steam in Creosoting Plants

By A. M. LOCKETT

Of A. M. Lockett & Company, Ltd., New Orleans

FROM the standpoint of an engineer interested in the general proposition of steam-plant economy, it has seemed to me that the managers of most wood-preserving plants are so intent on maintaining the maximum output that the question of steam economy has not received the attention to which it is entitled. While the volume of output is no doubt of the first importance, economy in steam consumption should not be entirely overlooked, since proper attention to this item would, in many cases, increase the output as well as effect an actual saving in cost per unit.

In the creosoting process, owing to the impossibility of securing air-dried materials, it is usually necessary to remove the moisture and sap by artificial means. The timber is introduced into the retort and is there subjected to heat by the admission of steam, the condensation of which transfers the heat to the wood. The principal if not the only useful function performed by the steam is to increase the temperature of the wood and the contained moisture, until it has reached the temperature of the steam.

It is impossible that any evaporation or removal of moisture can take place while the steaming process is in operation. As a matter of fact, the condensation of the steam in the pores and upon the surface of the wood increases temporarily to a great extent the amount of moisture present, and if one could examine the interior of the retort during this stage of the process he would find the condition of the wood almost equal to that which would exist were the wood submerged in water.

When the timber and the contained moisture reaches temperature equal to the steam, the pressure is released, the steam blown off and the retort immediately subjected to vacuum. As soon as the pressure is removed from the retort the heat contained in the wood and moisture cause violent evaporation, and as the pressure is still further reduced by the creation of a vacuum this evaporation becomes more intense.

Probably there is not in the timber, the water and this moisture sufficient heat to furnish the latent heat necessary to transform all of the liquid content into a vapor, but it is probable that the violent ebullition

which takes place in the interior of the wood furnishes sufficient vapor to push before it the liquid which has not been evaporated, and in this way the wood is rendered comparatively free from moisture. The moisture and air having been removed by the vacuum process, the wood is then ready for the introduction of the oil.

TOO FREE USE OF STEAM

In wood-preserving plants steam is used for heating the timber in the retorts, heating the oil in the retorts, heating the oil in the storage tanks, heating the buildings in winter, generating power for cranes and electrical equipment, and operating pumps, air compressors and other auxiliaries. There seems to be a common impression among the employees of these plants that so long as the boilers are there and capable of furnishing steam no special care need be exercised in the use of this steam. It would be just as sensible for employees of any establishment to take the position that so long as there is plenty of money in the safe in the office there is no good reason why this money should not be expended freely.

In many plants some of the combustible ingredients of the coal are not even burned, due to the type of furnace not being suitable for the particular fuel used, to unsuitable grates and to insufficient draft. The furnace should first be made to do its duty.

As it has been shown conclusively that a scale 1/16 in. thick will increase the loss of heat in a boiler by probably 20 per cent, it is of paramount importance that the heating surface of the boilers be kept thoroughly clean. The moment the steam passes into the header or main steam pipe it begins to part with its heat, and if the pipe is not properly covered by a suitable non-conductor, this loss is sufficient to justify covering all steam pipes and valves.

When the steam is admitted into the retort its first duty is to heat the retort itself, and in doing this a tremendous quantity of heat is required. It is probable that the preventable losses by radiation from a 7 x 120-ft. retort will equal 50 boiler horsepower. During the whole process of steaming the wood, the surfaces of the retort are rapidly radiating heat and consuming steam; therefore, all retorts used in this process should be properly protected by suitable non-conducting material. All steam leaks should be promptly stopped.

SAVING STEAM WITH THE AIR PUMP

One of the machines in the creosoting plant which requires a considerable quantity of steam to operate and which frequently uses very much more steam than is necessary, is the air pump. After the steam is first blown down from a retort, not only is the retort full of steam, but there is a rapid evaporation of the moisture in the wood. Therefore, at this time there is need of a very substantial condenser for those vapors which are capable of being condensed, in order that the work of the air pump may be only that for which it is legitimately intended. The largest part of these vapors can be quickly condensed merely by bringing them in contact with a spray of water, and the air pump only need remove those vapors and the air which cannot be condensed. If there is not a sufficient quantity of water the air pump is called upon to bail out the steam and vapors by actual displacement, requiring not only a large quantity of steam to drive the con-

denser, but also delaying very much the creation of the desired vacuum.

In one plant of large capacity the water available for condensing was only that which would enter through a 1 1/4-in. pipe from an elevated tank. In this plant it ordinarily required two hours to create the proper vacuum, although they had an air pump with a piston 22 in. in diameter and a 24-in. stroke. By increasing the water pipe to 3 in. it was easy to create the required vacuum in twenty minutes.

In many creosoting plants steam traps are not used upon heating coils, dependence being placed on the drainage of these coils by use of a valve; and in most cases these valves are improperly regulated so that there is a constant waste of steam, whereas with an automatic trap no steam whatever will pass through.

There are many plants using live steam in places where exhaust steam would serve the purpose just as well. I refer to the heating of oil in tanks and to the heating of plants and offices in the winter. There is usually sufficient exhaust steam available at all times for the air compressors, pumps and engines to do all this heating with steam which would be otherwise thrown away.

UNNECESSARY PUMPING OF WATER

In some plants the entire water supply is pumped to an elevated tank, and water from the elevated tank brought down to the surface again for use in the condenser, when the condenser would operate just as well with water which has not been previously pumped.

In plants where pulling and hoisting steam engines are located in the yards remote from the boiler plant, the steam supply pipes are rarely ever properly covered; and, not only is there a tremendous waste of steam, but serious injury to the engine takes place due to water in the pipe and the interference with the proper lubrication of the engine by the presence of this water.

A great waste of steam takes place frequently by reason of bad condition of valves and pistons on the water ends of pumps. So long as the pump is maintaining the desired pressure, it requires just as much steam to force the water by leaky pistons and through leaky valves as it does to force this water into the boilers or into the tanks, whichever the case may be. The same thing applies to pumps used for handling the creosote oils. A large quantity of steam is also wasted on account of insufficient cylinder lubrication of steam pumps from leaky steam piston rings and leaky slide valves. In some plants which are apparently well conducted the steam consumption of the pumps is probably twice what it ought to be, on account of the condition of the pumps.

The heating of feed water by exhaust steam is a very direct and positive way to save fuel. All plants have heaters, but due to the fact that at the time the retort is under steam, at which time there is the maximum demand for steam, many of the auxiliaries are shut down, there is frequently not enough exhaust steam available to heat the water to the proper temperature. Not only can a substantial saving in fuel be made, but greater boiler capacity can be obtained by using a large, covered and closed tank as an accumulator of hot water, this water being heated during the time that there is a surplus of exhaust steam.

Preliminary Estimating of Canal Excavation

Analyses of Numerical Examples Embodying Three Typical Prism Sections—How to Prepare Tables to Simplify Computations

By LEWIS M. HAMMOND

Assistant Engineer, U. S. Reclamation Service, Provo, Utah

A PRELIMINARY estimate is required of the excavation involved in the construction of a canal, having given a profile of the center line of the canal, the grade line of the canal, and a topographic map with the located line shown on it. Obviously formulæ are required which are based on the center cut, which can be obtained from the profile, and on the approximate average slope of the surface of the ground, which can be obtained from the topographic map. If no profile has been taken in the field one can be deduced from the topographic map and "paper location" which will be sufficiently accurate for a rough preliminary estimate, although much better results can be obtained with an accurate profile.

It will be assumed that the canal will, at different points, have three different sections, (1) an unlined section with unequal side slopes (see Fig. 1), (2) a concrete-lined section with equal side slopes (see Fig. 2) and (3) a concrete flume section for which a bench must be excavated (see Fig. 3). Formulæ will be developed for a typical example of each of the above three sections, using definite numerical bottom widths, side slopes and depths, but the methods used are applicable to any similar sets of conditions, and formulæ for these other conditions may be as readily worked out. If these numerical substitutions were not made here the formulæ would become much involved.

Case 1.—This is the type shown in Fig. 1 and worked out by means of Fig. 4. The right and left sides of the figure are considered independently.

Considering first the left side, let M = the vertical distance from the ground surface to the point B (or G) formed by the intersection of the center line of the canal with the side slope line, and s , the natural slope of the ground, in feet vertical per foot horizontal; let the X and Y axes be as shown, with O , the origin of co-ordinates, on the ground surface. The figure will then be studied by means of analytic geometry.

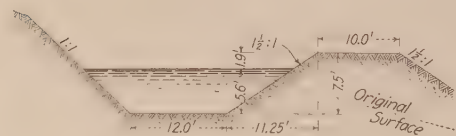


FIG. 1

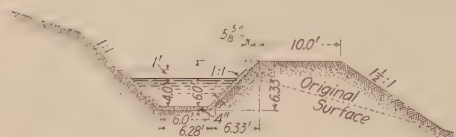


FIG. 2

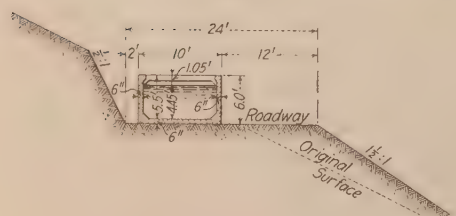


FIG. 3

The equations of the lines BA and OA are respectively

$$y = x + M \quad (1)$$

and

$$y = x/s \quad (2)$$

Solving for A , the point of intersection,

$$y = x + M = x/s \quad (3)$$

Hence

$$x = sx + Ms$$

or

$$x = Ms/(1 - s) \quad (4)$$

Substituting in equation 2,

$$y = Ms/s(1 - s) = M/(1 - s) \quad (5)$$

Therefore

$$\begin{aligned} \text{area of triangle } AOB &= My/2 \\ &= M^2/2(1 - s) \end{aligned} \quad (6)$$

and

$$\begin{aligned} \text{area of quadrilateral } AOED &= M^2/2(1 - s) \\ &\quad - DE \times EB/2 \end{aligned} \quad (7)$$

or, since $DE = 6$ and $EB = 6$,

$$\text{area } AOED = M^2/2(1 - s) - 18 \quad (8)$$

Considering the right side of the figure, the equations of the lines GC and OC are respectively

$$y' = (3/2)(M' - x') \quad (9)$$

and

$$y' = x'/s \quad (10)$$

Equating as before,

$$x'/s = (3/2)M' - (3/2)x'$$

whence

$$x' = \frac{(3/2)M's}{1 + (3/2)s} \text{ and } y' = \frac{(3/2)M'}{1 + (3/2)s} \quad (11)$$

Therefore

$$\begin{aligned} \text{area } OCG &= M'y'/2 \\ &= 3/4(M')^2/[1 + (3/2)s] \end{aligned} \quad (12)$$

and

$$\begin{aligned} \text{area } OCFE &= 3/4(M')^2/[1 + (3/2)s] \\ &\quad - EF \times EG/2 \\ &= 3/4(M')^2/[1 + (3/2)s] - 12 \end{aligned} \quad (13)$$

Now let N = the actual center cut, EO , as obtained from the profile. Then $M = N + 6$, $M' = N + 4$, in equation 8

$$\text{area } AOED = \frac{(N + 6)^2}{2(1 - s)} - 18 \quad (14)$$

and in equation 13

$$\text{area } OCFE = \frac{3/4(N + 4)^2}{1 + (3/2)s} - 12 \quad (15)$$

Adding equations 14 and 15,

$$\begin{aligned} \text{area } ACFD &= \frac{(N + 6)^2}{2(1 - s)} \\ &\quad + \frac{3(N + 4)^2}{4[1 + (3/2)s]} - 30 \end{aligned} \quad (16)$$

It will be most convenient to deal with a prism one station or 100 ft. in length, hence in preparing tables as described later the above area $ACFD$ must be multiplied by 100/27, this giving the amount of excavation in cubic yards per 100-ft. length of canal. If the excavation for a shorter section is required it is only necessary to divide by 100 and multiply by the desired length.

Case 2.—This case is typified by Fig. 2 and solved by means of Fig. 5. Considering the left side first, the discussion of case

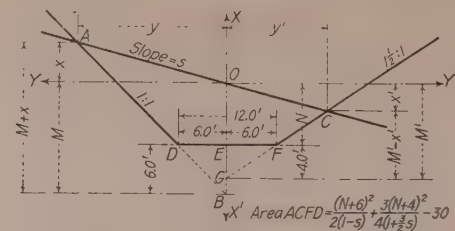


FIG. 4

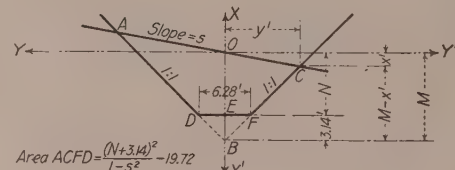


FIG. 5

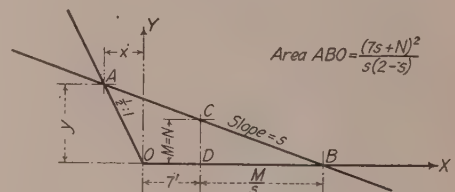


FIG. 6

1 applies up to and including equation 7. In this case, however, $DE = 3.14$ and $EB = 3.14$, hence

$$\text{area } AOED = M^2/2(1 - s) - 9.86 \quad (17)$$

Considering the right half of the figure, the equations of the lines BC and OC are respectively

$$y' = M - x'$$

and

$$y' = x'/s$$

Solving for the co-ordinates of the point of intersection,

$$x'/s = M - x'$$

or

$$x' = Ms/(1 + s) \quad (18)$$

and

$$y' = x'/s = M/(1 + s) \quad (18a)$$

Then

$$\text{area } OCB = \frac{My'}{2} = \frac{M^2}{2(1 + s)} \quad (19)$$

and

$$\text{area } OCFE = \frac{M^2}{2(1 + s)} - \frac{EF \times EB}{2}$$

or, since $EF = 3.14$ and $EB = 3.14$,

$$\text{area } OCFE = \frac{M^2}{2(1 + s)} - 9.86 \quad (20)$$

Adding equations 17 and 20,

$$\begin{aligned} \text{area } ACFD &= \frac{M^2}{2(1 - s)} - 9.86 \\ &\quad + \frac{M^2}{2(1 + s)} - 9.86 = \frac{M^2}{1 - s^2} - 19.72 \end{aligned} \quad (21)$$

If N = the actual center cut EO , as before, $M = N + 3.14$, and equation 21 becomes

$$\text{area } ACFD = \frac{(N + 3.14)^2}{1 - s^2} - 19.72 \quad (22)$$

and multiplying this by 100/27 will give the yardage of cut per 100-ft. station.

Case 3.—Figs. 3 and 6 apply to this case. Let the X and Y axes be as shown, and let O be the center of co-ordinates. The equations of the lines OA and BA are respectively

$$y = 2x$$

and

FORM FOR COMPUTATION OF QUANTITIES

Station	Section	Ground elevation	Grade elevation	Subgrade elevation	Center cut	Slope of ground	Quantity for 100 ft.	Actual quantity
100+00	type 2	69.4	63.1	62.8	6.6	0.10	278	139
100+25	type 2	75.3	63.1	62.8	12.5	0.10	337	466
101+00	type 2	71.0	63.1	62.8	8.2	0.10	405	215
101+50	type 2	71.3	63.0	62.7	8.6	0.20	455	129
102+00	type 2	65.5	63.0	62.7	2.8	0.20	61	91
103+00	type 2	66.5	63.0	62.7	3.8	0.30	121	

$$y = s (OB + x)$$

Equating to find the co-ordinates of the point of intersection,

$$2x = s (OB + x)$$

or

$$x = OB \times s / (2 - s)$$

and

$$y = 2x = 2s \times OB / (2 - s)$$

Hence

$$\text{area OAB} = OB \times y / 2 = s \times OB^2 / (2 - s) \quad (23)$$

Now $OB = OD + DB$, $OD = 7$, and $DB = M/s$; or since $M = N$, $DB = N/s$, and

$$\begin{aligned} \text{area OAB} &= \frac{s [(7s + N)/s]^2}{(2 - s)} \\ &= \frac{(7s + N)^2}{s(2 - s)} \quad (24) \end{aligned}$$

and multiplying this by 100/27 will give the yardage of excavation per 100-ft. station.

TABLES

While these three formulæ are apparently quite complicated it will be noticed that for varying values of N , and any given value of s , the formulæ may be divided into one or two portions which may be very easily worked out with one setting of a slide rule and a table of squares. (Results obtained with a slide rule will be of an accuracy commensurate with the other quantities involved.) Tables can thus be prepared giving the quantity of excavation in cubic yards per 100-ft. station for various center cuts and natural ground slopes, carrying the tables as far as there is any likelihood of the actual center cuts and ground slopes occurring. For average conditions it might be well to prepare tables with center cuts varying by 0.5 ft. up to 25 ft., and with natural ground slopes varying by 5 per cent up to 75 per cent.

If desired the tables may be worked out by the well-known method of "second differences," instead of with a slide rule. For example, for any center cut N , say 2 ft., the volume of excavation will be A cubic yards per station. Then for $N = 2.5$ ft. the volume will be $A + K$; for $N = 3.0$ ft., $(A + K) + K' + K$; for $N = 3.5$ ft., $(A + 2K + K') + K + 2K'$; for $N = 4.0$ ft., $(A + 3K + 3K') + K + 3K'$; for $N = 4.5$ ft., $(A + 4K + 6K') + K + 4K'$; for $N = 5.0$ ft., $(A + 5K + 10K') + K + 5K'$, etc., where K and K' are constants which may be determined by either of two methods. One is by working out the formulæ for $N = 2.0$, 2.5 and 3.0 ft. (or any other three consecutive quantities) and then obtaining K and K' by simple subtraction. The other is by working out the formulæ for three different center cuts varying by ten intervals (in this case 5 ft.) each, say 2.0, 7.0 and 12.0 ft., and then solving for K and K' by means of the two following simultaneous equations:

$$\begin{aligned} \text{volume}_{N=7} &= \text{volume}_{N=2} + 10K + 45K' \\ \text{and} \\ \text{volume}_{N=12} &= \text{volume}_{N=2} + 20K + 190K' \end{aligned}$$

The derivation of these two formulæ is evident from an inspection of the series shown in the previous paragraph. The second method is slightly longer than the first, but has the advantage of having two quantities already worked out with which to check the addition work as it proceeds. If the tables are carried very far by this method of "second differences" it will be necessary to compute K and K' with great accuracy, say to five decimal places.

It should be noted that in cases 1 and 2 this method of "second differences" should not be employed until the center cut N is large enough so that the point C (Figs. 4 and 5) falls on the line GC (or BC), and not on the line EF .

After the tables have been prepared the estimate may be completed. The accompanying or some similar form for the detailed computations is recommended, as with it the work will be easy to check and to keep in order. The table is self-explanatory and is readily filled out with the aid of the profile, topographic map and tables.

An estimate prepared by this method will not, of course, take into consideration borrow or overhaul, for which a mass diagram must be prepared; but it will be sufficiently accurate for a preliminary estimate, and will be very satisfactory as such, provided the length of the canal is sufficient to warrant the time and labor necessary in preparing the tables.

West Fork Waterworks Dam at Fort Worth

Combined Earth and Concrete Dam—The Spillway Section was a Subject of Contention Among Members of Engineering Board

FORT WORTH, TEXAS, is today supplied with water obtained from deep wells tapping the Paluxy and Trinity sands of the Upper Cretaceous formation. The Paluxy sands, in general, are found at a depth of 160 to 200 ft. in the lowlands near the Trinity River, and the Trinity sands 900 to 1000 ft. The Glen Rose sands lie between the Paluxy and Trinity, and contribute some water, where casings are perforated, in a few wells. As an auxiliary supply there are three small masonry dams in the channel of the Clear Fork of the Trinity River, located 1, 6 and 8 mi. west of the city respectively. All wells are pumped by direct air-lift, the water plane falling to about 250 ft. below surface during pumping. Various industries and individuals operate about 250 wells tapping the same sands. The several municipal well groups furnish about 5,000,000 to 6,000,000 gal. daily, and private wells probably an equal amount.

WATER SUPPLY SURVEY

Due to the enormous expense of air-lift pumping, resulting in a continually increasing deficit in waterworks finances, although

nearly all water municipally pumped is sold through meters, the city government in 1910 ordered a comprehensive survey of water supply conditions. This survey was made by a board of engineers composed of J. D. Trammell, city engineer, selected by the city commission; John B. Hawley, consulting engineer, selected by the Fort Worth Chamber of Commerce; and Prof. T. U. Taylor, dean of the college of engineering, Texas State University, selected by Messrs. Trammell and Hawley. Professor Taylor resigned from the board in December, 1912, and in February, 1913, W. B. King, general manager of the Fort Worth Stock Yards Company and Fort Worth Belt Railway, was appointed in his place. Both Messrs. King and Hawley resigned in January, 1914. Early in 1911, this board reported to the City Commission, recommending an impounding and storage reservoir on the West Fork, or main branch of the Trinity River, the location of the dam being about 6 mi. in air line from the waterworks pumping station. The drainage area above the West Fork site is about 1800 sq. mi. Mr. Hawley submitted a minority report, advocating a reservoir on the Clear Fork,



EIGHTEEN INCHES OF WATER OVER THE WEST FORK DAM AT FORT WORTH



STEEL SHEET PILING DISCONTINUED WHERE MOST NEEDED

at a point about 7 mi. from the pumping station. The drainage area of the Clear Fork site is about 500 sq. mi. and the average annual rainfall is about 30 in. Upon adoption of the majority report the same board of engineers was retained to design and supervise construction of the reservoir and appurtenances. Construction work was commenced in November, 1911, and prosecuted in a desultory manner by the contractor until April, 1913, when the city took over the work, continuing construction by day labor, and by October, 1914, the dam was substantially completed and full of water.

DAM AND SPILLWAY

The earthen embankment portions of the dam, 1000 ft. long on the north end and 2000 ft. on the south end of the 7000 ft. of spillway have 1 on 3 slopes on the water face, and 2 on 1 slopes on the downstream face, the top berm being 50 ft. wide. There is a berm 30 ft. wide on both faces at El. 590, top of embankment being at El. 621. The crest of the spillway is at El. 609, giving 12 x 700 ft. of free waterway. Very few cross-sections of the valley above the dam were made, but it is probable that the total storage capacity is 20,000,000,000 gal., of which 12,000,000,000 gal. are accessible to the conduit, whose invert is at El. 590.

The masonry section or spillway is located about 100 ft. to the south of the old river channel, upon a rock base comprising alternate layers of limerock and shale belonging to the Upper Cretaceous formation. All masonry is of gravel concrete mixed in the proportions of 1 to 7. Pit gravel was

found near the work, containing an ample amount of good sand, generally a surcharge. About 30 per cent of limestone "plums" were hand-placed in the soft concrete. Fig. 1 shows the masonry section as constructed and Fig. 2, the section in-



HEADGATE FOR 48-INCH DRAIN, LOOKING WEST

sisted on by Professor Taylor and Mr. Hawley, without avail.

The embankment was laid up in 1-ft. layers, wetted and rolled, of materials obtained largely below the dam. Elevating graders, a steam shovel, dump wagons and wheeled scrapers were all used in moving the earth. The embankment is planted in Bermuda grass on top and downstream slope, while the water face is partly riprapped and partly concrete lined. As a drain 300

ft. of 48-in. cast-iron pipe were laid under the embankment in a trench excavated in the rock. The pipe was wholly surrounded with concrete filling the trench and extending 1 ft. above the top of the pipe.

SHEET PILE CORE DISCONTINUED

Design for embankment work included a core of 35-lb. Lackawanna steel sheet piling, as shown herewith, but this was not continued 80 ft. across the old river channel where it would appear to be most needed. The city government is reported to have excused the contractor from this task, because the contractor had shipped his pile-driver back to St. Louis. Engineers who know of the details are apprehensive that this kindness of the city may some time result in serious consequences. Below the drag bucket shown in the photograph near the end of the piling the sand and gravel layer over the rock is about 20 ft. thick.

Water will be delivered to the filtration plant at the main pumping station by a reinforced-concrete gravity conduit, 48 in. in diameter on the upper 3 mi. and 36 in. in diameter in the remaining 3½ mi. There are three inverted siphon river crossings of special construction. The precast concrete pipes are of the Parmley type, 4 ft. in length, laid in trenches, many of which were excavated by a Parsons trench machine. Hauling the sections from the pipe making plant near the city to the trenches was done with a train of three 10-ton Avery trailers pulled by an 80-hp Russell tractor. A novel feature in this plant was a jolting machine for the concrete molds. A cam on a revolving shaft lifted steel mold car and track. Concrete was mixed in a motor-driven Milwaukee mixer and the molds, each mounted on a separate car, were lifted from the pipes by a Shepard electric crane operating over a runway of 650 ft. Due to the differences between the contractors and the city, arising over partial tests for leakage, work on the conduit has been suspended for several months. The capacity of the conduit, diameters and gradients considered, is easily 20,000,000 gal. per day.

The filtration plant, completed in January, 1912, was described in Engineering Record, Aug. 24, 1912, page 214. Awaiting completion of the conduit, water is delivered to the filter plant direct from the river by electrically-operated centrifugal pumps, located about 300 ft. from the plant.

The Underground Construction Company, of St. Louis, Mo., was contractor for the dam, the Hedges Construction Company, of Springfield, Mo., for the conduit, and the Pittsburgh Filter Manufacturing Company, of Pittsburgh, Pa., for the filters.

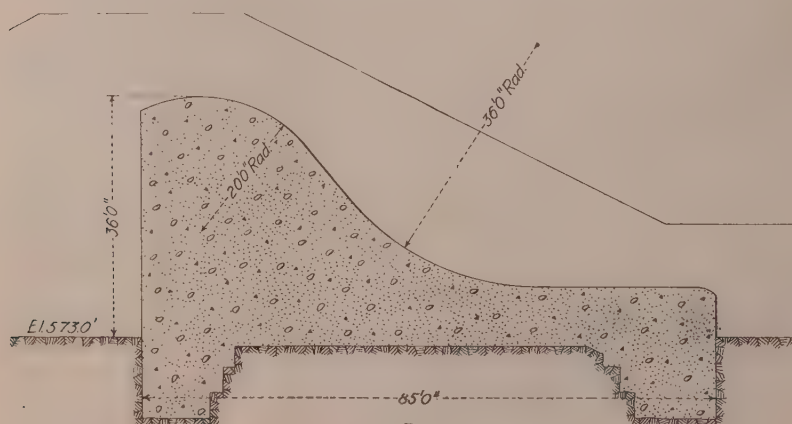


Fig. 1

APPROXIMATE SECTION OF DAM AS CONSTRUCTED

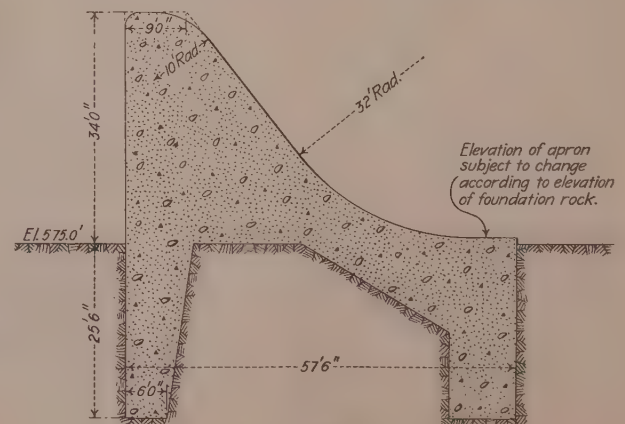


Fig. 2

REJECTED TAYLOR AND HAWLEY SECTION

Book Reviews

The U. S. Geological Survey has issued recently Water Supply Paper 335, containing 365 pages, 17 figures, 9 plates, and 1 insert, entitled "Geology and Underground Waters of the Southeastern Part of the Texas Coastal Plain." The author is Alexander Deussen.

The Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the fiscal year ended June 30, 1914, has appeared in printed form. The report contains 99 pages and is divided into three parts—functions, organization and location; scientific and technical divisions; and office, engineering and construction. (Washington, D. C., Government Printing Office.)

Wood pipe for conveying water for irrigation is discussed by S. O. Jayne, irrigation manager, in Bulletin 155 of the U. S. Department of Agriculture. The booklet, which contains 37 pages, contains a number of illustrations and tables of practical use to irrigation engineers. Continuous stave pipe and machine-banded pipe are described in detail and many specific instances are given to show how long wooden pipe lines may be expected to last under special conditions. (Washington, D. C., Government Printing Office.)

GRAPHICAL DETERMINATION OF SAGS AND STRESSES FOR OVERHEAD LINE CONSTRUCTION. By Guido Semenza, Consulting Engineer, and Marco Semenza, Electrical Engineer. Translated from the Italian by C. O. Maillaux, Consulting Electrical Engineer. Cloth, 9 x 12 in.; 24 pages; 13 charts. New York, McGraw-Hill Book Company. \$3 net.

(Reviewed by R. Fleming of the American Bridge Company, 30 Church Street, New York City.)

Guido Semenza, the senior author of the above book, a consulting engineer of Milan, Italy, is an occasional contributor to the technical press and holds a high place among the world's electrical transmission engineers. He was the originator of the flexible pole or tower used extensively in transmission systems in both Europe and this country. The reviewer calls attention to this fact because in all the literature he has read on flexible towers Semenza is mentioned but twice. Even the writer of the article on electrical power transmission in the Encyclopædia Britannica credits the design to "the Italian engineers."

The 24 pages of the text are divided into five parts. Parts I and III give instruction on how to use the charts. Parts II and V present the scientific and mathematical principles employed in the construction of the charts. These principles are similar to those followed in the paper by Pender and Thomson referred to in the bibliography. Part IV consists of notes on coefficients and constants, the measurement of temperature and the regulations prescribed by various societies.

The purpose of the charts, as stated by the author, is to provide curves for the installation of copper conductors which require no calculations on the part of those using them. The charts are unique. The ratio of unit weights of loaded to unloaded wire, called m , is first obtained from Chart 1. This can be found for wires ranging from sectional areas of 6530 to 212,000 circular mills, wind velocities from 0 to 120 mi. per hour and ratios ($K=D/T$) between the diameters of the ice coating and those of the bare wire from 1 to 10. With

the value of m the sags and tensions may be determined from the remaining charts for all cases coming within the limits of hypothetical spans $L = m l$ (l = length of true span) from 80 to 4000 ft., hypothetical sags $F = m f$ (f = true sag) from 0 to 300 ft. and mechanical stresses in the conductor wire from 1000 to 27,000 lb. per square inch.

For supports on the same lever, the method is short and easy to follow, and gives results sufficiently accurate for all practical purposes. The same degree of accuracy may be attained when the supports are not on the same lever, though the processes are longer.

Most engineers will disagree with the translator regarding sags and stresses being determined in the field by the foreman in charge of construction and will prefer that charts be made in the office. The translator is in error in stating that the mathematics employed in parts II and V involve merely an elementary knowledge of algebra. However, it is not necessary to understand the mathematics of the book to be able to use the charts.

The printing is in clear type and the book presents an attractive appearance. It is unfortunate that the text is marred by many errors. These are due to carelessness either in proofreading or in the preparation of the English manuscript. Some are trifling but others are annoying. The reviewer noted fifteen corrections that should be made in addition to the nine given in the printed list of Errata.

The bibliography could easily be made longer. A reference to Weisbach's "Theoretical Mechanics," Section III, chapter 4, would not be amiss.

The transmission engineer will find this book a valuable supplement to whatever method he may be using in determining sags and tensions in wires. He may come to use it altogether.

AMERICAN SEWERAGE PRACTICE, DESIGN OF SEWERS—VOL. 1. By Leonard Metcalf and Harrison P. Eddy. Cloth, 6½ x 9 in.; 747 pages; 328 illustrations. New York, McGraw-Hill Book Company. \$5 net.

(Reviewed by Charles E. Gregory, Board of Water Supply, New York City.)

This volume meets a real need for a complete reliable statement of current engineering practice in an important branch of municipal engineering. The authors have not only summarized in this one volume the published opinions on disputed points of a large number of engineers who are actually doing much of the sewerage work of the country, but have also described the actual practice from its early development to the present time, giving many examples of typical designs as now used in important American cities.

The elements of the theories of hydraulics, sanitation and structures have been concisely stated, but the authors apparently did not intend the work for an elementary textbook. They apparently assume that users of the book have at least an elementary knowledge of the mathematics, mechanics and physics involved.

No textbook has ever before so completely dealt with many of the more difficult and uncertain elements of sewer design. Each step has been worked out to the most advanced point and all of the details have been fully covered. The authors have not, as so often happens, specialized on a few of the elements of the problem at the expense of others, but have carefully covered

the entire field. The art of sewerage design and construction has developed more largely from experience than from strictly scientific research and experimentation, and the authors in the introduction have briefly outlined the pertinent history of that development, both abroad and at home, in order to point out the lessons taught.

The various steps necessary to arrive at a complete design of a comprehensive sewerage system is taken up in seventeen chapters. These have been arranged in the order of their logical development. Each one shows evidence of having for its basis the complete notes of a successful student and designer. The conclusions are clearly stated, without being dogmatic, and have set standards for the determination of sizes and forms of structures which may well be followed and which may ultimately do much to unify American practice.

Chapter 1 takes up "The General Arrangement of Sewerage Systems" and points out many of the troubles with early systems. The correction of these mistakes has led the authors to an exhaustive discussion of the "Hydraulics of Sewers" in chapters 2 to 4 inclusive and of "Quantity of Sewage" in chapter 5. One of the most original and valuable sections of the book is embraced in chapters 6 to 9 inclusive, which cover the gagings and determination of the capacity of storm-water sewers. There has probably been more discussion and a wider range of opinion upon this subject than upon any other feature of sewer design. Reliable data from which safe conclusions may be drawn for each of the elements of the problem are not available, but the authors have shown how such data as are to be had have been obtained and what relation they bear to the final result and previous practice. The field is covered, giving credit to those who have contributed to it, and many useful diagrams are included. The so-called rational method is recommended and is shown to be used more than any other method. The use of this method is steadily growing, the Borough of Manhattan, New York City, and the Public Service Commission of the Second District, New York, having adopted it since the data were collected by the authors.

Chapters 10 to 13 cover forms of sewer structures in use and methods for their design, and give evidence of great diversity in American practice. Many engineers have used only crude or empirical methods of design when determining sewer sections. This practice has been excused on the ground that the uncertainty of the pressures exerted by the surrounding earth make the problem to a degree indeterminate. Much progress has been made, however, in the determination of these pressures and in rational and complete analysis of the resulting stresses in the sewer section. The authors have carried this part of the work to an advanced stage.

Chapters 14 to 17 cover the design of accessory structures and pumping stations and consist of descriptions and illustrations of the better examples of works as used in various localities.

RECENT TIMBER SALES by the Government totaling 126,000,000 ft. of saw timber in the Olympic National Forest in western Washington mark the opening of this hitherto inaccessible storehouse of timber, estimated to contain a stand of 33,000,000,000 ft. b.m.

Letters to the Editor

Wrong Price Given for New Book on Concrete-Steel

Sir: In the Engineering Record of Jan. 9, page 56, there is a review by Prof. F. H. Constant of the new book on concrete-steel construction by Eddy and Turner, in which the price is set at \$20 net. This is an error, inasmuch as the price of the book is \$6 net.

C. A. P. TURNER,

Minneapolis.

Per V. L. Fixen.

[The price was originally stated to be \$20, and this journal was not advised of any change.—EDITOR.]

Why Columns Failed in Edison Fire

SIR: The following is an extract from a series of fire tests on brick concrete made recently at the University of California Testing Laboratory, which may explain to some extent the column failures in the Edison fire at West Orange, N. J. While the aggregates in the two cases are different, the actions of each under the same conditions would probably be similar.

The purpose of the tests was to determine the effect of heating and of quenching on the strength of brick concrete. The specimens were 6 x 16-in. cylinders and the apparatus used was a gasoline case muffle furnace, a Bristol base metal pyrometer and a 100,000 lb. Riehle testing machine.

The specimens were heated in the blast furnace for a period of four hours. Temperature readings were taken each hour. At the end of four hours half of the specimens were taken out and water was applied with a hose. The remaining half was tested to compression failure after being allowed to cool slowly.

RESULTS OF QUENCHING TESTS

Specimen number	Mix	Weight per cu. ft., lb.	Temperature readings, centigrade				Load, lb.	Intensity, lb. per sq. in.
			1 Hr.	2 Hr.	3 Hr.	4 Hr.		
1	1:2:4	130	220	420	580	770	.....	.....
2	1:2:4	135	220	420	580	770	.....	.....
3	1:2:4	128	220	420	580	770	.....	.....
4	1:2:4	127	220	420	580	770	16,490	584
5	1:2:4	132	220	420	580	770	19,090	675
6	1:2:4	137	220	420	580	770	21,140	748

It was planned to make more than six tests, but a breakdown in the furnace prevented further work.

The aggregate was clean crushed brick, the sizes ranging from that rejected by a 1/4-in. screen to that passing a 1/2-in. ring. The sand was an approximate 1:1 mixture of clean beach sand and clean top gravel. The cement was the Mt. Diablo brand of Portland cement.

The first three specimens, quenched on removal from the furnace, were completely broken up and worthless for compression tests. Their destruction was accompanied by loud reports, some of the pieces flying 12 or more feet away from the specimen. Some such action undoubtedly took place at the Edison plant.

The strength of the three unquenched specimens, while not high, was still great enough to make the concrete of some value in compression, and except for a few small cracks these cylinders were apparently in good condition, no large amount of damage being visible.

WM. E. DAVIS,
Civil Engineer.

San Francisco.

Restoring Reinforced-Concrete Columns

Sir: I read with interest your reports on the recent fire in the Edison plant, at West Orange, N. J., and the failure of certain columns brought to mind the solution worked out for a similar problem at the

Hershey Chocolate Company, at Hershey, Pa., on which construction is now in progress. I am sending you a photograph taken Dec. 21, showing the details of this job.



COLUMN WITH EXTRA REINFORCEMENT

The problem was to take a two-story reinforced-concrete building, in which columns and foundations had been designed to carry one floor and one roof load, and convert this building into a four-story reinforced-concrete building. This made it necessary for the foundations and the first-floor columns to carry three floors and one roof load. This was accomplished by shoring up the entire existing building, carrying new foundations down to rock over the old spread footings and grouting the new concrete to these footings with pressure. The structural steel, which furnishes the additional strength on these columns, was designed with a bearing plate, so that it was carried on concrete outside of the concrete carrying the original column loading, and the steel itself was of course a lattice column, designed to carry the additional load occasioned by the reconstruction of the building.

JOHN H. WICKERSHAM,
Designing and Constructing Engineer.
Lancaster, Pa.

Coal-Tar and Creosote Mixtures

SIR: In my article "How the Wood-Preserving Industry Can Avoid Possible Injury Resulting from the European War," published in the Engineering Record of Sept. 26, 1914, page 346, the use of coal-tar and creosote mixtures was inadvertently omitted. This article has produced much favorable attention and discussion. A critic of the Forest Products Laboratory, however, has inferred that this laboratory did not consider the use of coal-tar and creosote mixtures desirable. Because of this, I am writing this letter, in order that the position of the laboratory might not be further misunderstood. The Forest Products Laboratory has never taken a definite position either for or against the general

practice of mixing coal tar with creosote.

The laboratory does not oppose the proper admixture of tar and creosote, but considers that so far as it knows, there are not sufficient authentic data available to prove definitely its value, and until such data are available the laboratory feels that a definite recommendation for or against its use can not be made by it.

It is felt, however, that the treatment of certain kinds and classes of timber with a mixture of tar and creosote is well worthy of extensive trial along with the other suggestions made in the above article.

CLYDE H. TEESDALE,
In Charge, Section of Wood Preservation,
U. S. Forest Products Laboratory.
Madison, Wis.

Electric Operation for Stone Quarries

SIR: I have just read with great interest the article by A. W. Carroll in the Engineering Record of Jan. 2, 1915, page 18, relative to the electrically operated contractor's plant for building the Kensico Dam.

I desire to say that from my experience in operating a marble quarry with both steam and electricity I concur with every conclusion drawn by Mr. Carroll as to the desirability of electric operation. The Alabama Marble Company is gradually changing its equipment from steam to electric. We figured the advisability of using compressed air for drills and channellers, but it required no careful investigation to point very clearly to the advantage of passing at once to the electrically operated machines.

There is no longer any question whatever that every stone quarry in the United States ought to be operated electrically. The only economical application of compressed air is for blowing out holes and sharpening bits, just as Mr. Carroll states. Not only is electric operation cheaper, but the work done by the machines is slightly greater, and the greater convenience of the electric transmission makes an indirect addition to the efficiency of the working force, which is greater than the increased work done by the machines. As very few quarries are equipped with electric machinery, this article was of considerable interest to the writer, for the reason that it confirms every conclusion reached by him in considering the question of new equipment for this company. Possibly Mr. Carroll may be glad to know that, on the other hand, the experience of this company confirms every conclusion that he reaches in his article.

JOHN STEPHEN SEWELL,
Vice-President and General Manager, Alabama Marble Company; Late Major, Corps of Engineers, U. S. A.
Gantt's Quarry, Ala.

A DIVER'S SUIT for work down to a depth of 300 ft. was exhibited at the second International Exposition for Safety and Sanitation held at the Grand Central Palace, New York City, Dec. 12 to 19. The suit is made entirely of metal and the diver works under a pressure slightly above the atmospheric pressure. The suit has been tested at the shops for a hydrostatic pressure corresponding to a depth of more than 300 ft. and last July a diver descended in such a suit 212 ft. below the water surface of Long Island Sound.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[Contributions to this section are solicited, and if found available will be paid for. They must be SHORT, and should be accompanied, if possible, by photographs or sketches.—EDITOR.]

Safety First on Steam Shovels

ACCIDENTS to employees who operate the 130 steam shovels used by the Oliver Iron Mining Company for stripping overburden, digging ore and loading from stock piles, have been minimized by equipping all of the machines with safety devices of various sorts. The accompanying photo-

graph shows a shovel fitted with guards at every point where such devices can be installed to advantage, has been received from W. J. Olcott, president of the company, who is taking an active interest in preventing injuries to his men. It is necessary to oil the sheaves at the point of the boom, and it is to be observed that a permanent steel ladder-way is constructed, having a pipe hand-rail, so that a man can climb to the point of this boom in perfect safety. It will be further observed that the large spur gear on the shipper shaft and the pinion which engages with it are completely enclosed. This guard is fabricated from heavy sheet steel and becomes a permanent part of the shovel.



CASED GEARS, HAND RAILS AND OTHER DEVICES ON A SAFETY-FIRST STEAM SHOVEL

graph, showing a shovel fitted with guards at every point where such devices can be installed to advantage, has been received from W. J. Olcott, president of the company, who is taking an active interest in preventing injuries to his men.

It is necessary to oil the sheaves at the point of the boom, and it is to be observed that a permanent steel ladder-way is constructed, having a pipe hand-rail, so that a man can climb to the point of this boom in perfect safety. It will be further observed that the large spur gear on the shipper shaft and the pinion which engages with it are completely enclosed. This guard is fabricated from heavy sheet steel and becomes a permanent part of the shovel.

Everyone familiar with steam shovel operation knows that there is always danger from breaking of the hoisting chain. In such cases accidents have occurred due to the end whipping around and catching the shovel runner. To prevent this, as will be noted from the cut, just back of the crane is a heavy sheet steel guard enclosing the chain and the sheaves at the heel

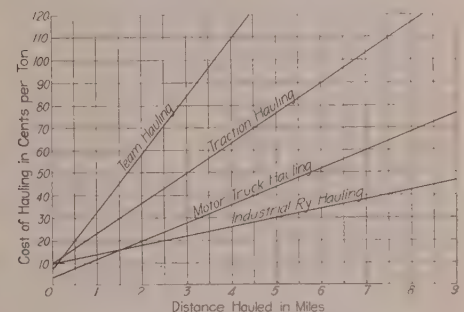
from front to rear. This running board is not only narrow but is liable to be slippery. It will be observed that a hand-rail made of pipe and constructed so as to be removable, extends the full length of the running board, so that there is no danger of a man falling from it. The photograph does not show the guards over the moving parts of the hoisting and swinging engines, nor the guard over the propelling gear under the shovel, but all gears and moving parts are covered with substantial guards.

It has been customary until recently to light steam shovels at night by gasoline torches. These have been entirely discarded, and the lighting is now accomplished by electricity obtained from a turbine-driven generator of 1 k.w. capacity. This generator will carry twenty-five incandescent lamps, which are ample to illuminate the pit ahead of the shovel so that the runner and crane can see their work at night as clearly as in the day time. Lights are placed underneath the shovels for the benefit of the pit men. As a safety device this lighting of steam shovels by electricity has reduced accidents very ma-

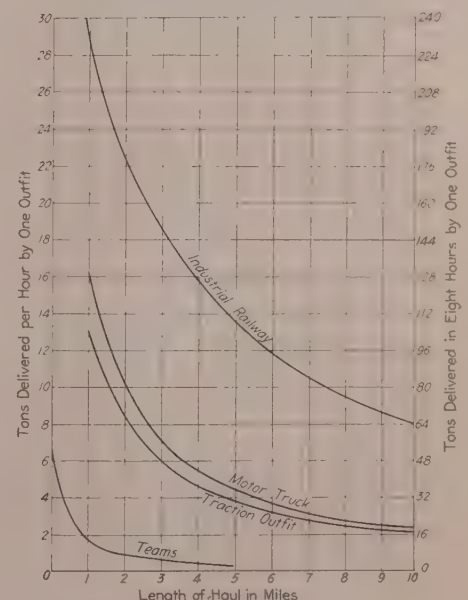
terially. Furthermore, the cost of lighting is less by this process than with gasoline. The superintendents in charge of the work are thoroughly convinced that there is a decided increase in the efficiency of both shovel and men gained by electric lighting.

Hints on Selecting Machinery for Road Building

PRINCIPLES that should govern in the selection of road machinery, as outlined by Prof. T. R. Agg at the recent Chicago convention of the American Road Builders' Association, depend on the price, rate of depreciation, cost of operation and speed of operation. As hauling is the large item, some tentative average figures of the various features affecting it are given. Rates of travel may be taken as $2\frac{1}{2}$ mi. per hour for teams, 8 to 10 mi. per hour for motor trucks, 3 mi. for tractors and 10 mi. for industrial railroads. Capacities for teams are 2 tons, for motors 5 tons, for tractors 15 tons, and for industrial railroads 20 tons. Costs of operation, including interest, depreciation, maintenance, supplies and labor, are 50 cents per hour for teams, \$2 per hour for tractors, \$3 per hour for motor trucks and \$4 per hour for trains of five cars and locomotives. Time of loading at



COSTS OF HAULING



RELATIVE HAULING SPEEDS

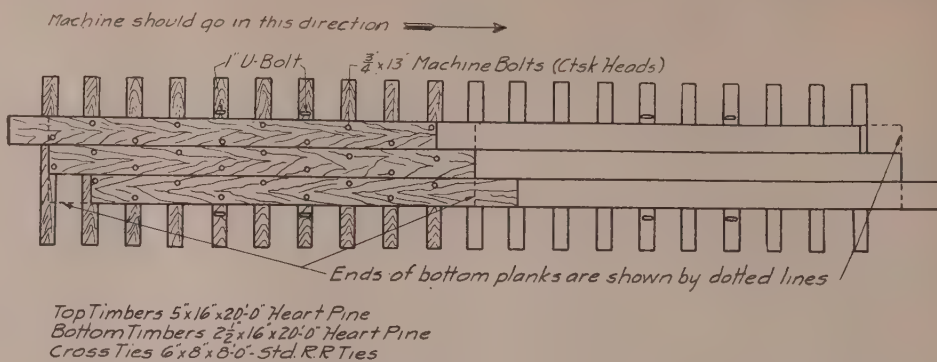
the siding is an important item, and it is a distinct advantage to have extra equipment here. Bins are quite necessary with all equipment other than teams.

Contractor Converts Wagon into Transformer Station for Pumping

A TRANSFORMER station mounted on a wagon is being used in connection with electrically driven centrifugal pumps to unwater sewer trenches at Salt Lake City. The contract, which was let to the Ulen Contracting Company, called for about 70 mi. of trench work, most of which is in water-bearing soil. The primary circuits of the Utah Light & Traction Company can be tapped within three blocks of any of the trenches to be pumped. The wagon transformer station is connected to the nearest point on this circuit, and portable cables as long as 2000 ft. are run from it to the pumps. The pumps are operated by 5-hp motors, and from six to ten may be run at a time from the one transformer station.

Gasoline Locomotive Hauls Material Trains for Concrete Highway

THE problem of transporting material to a moving mixing plant on concrete road work in Oregon has been solved by the use of gasoline-drawn industrial trains carrying eighteen dry batches each. At the nearest point of rail or water delivery there are erected storage bins into which sand



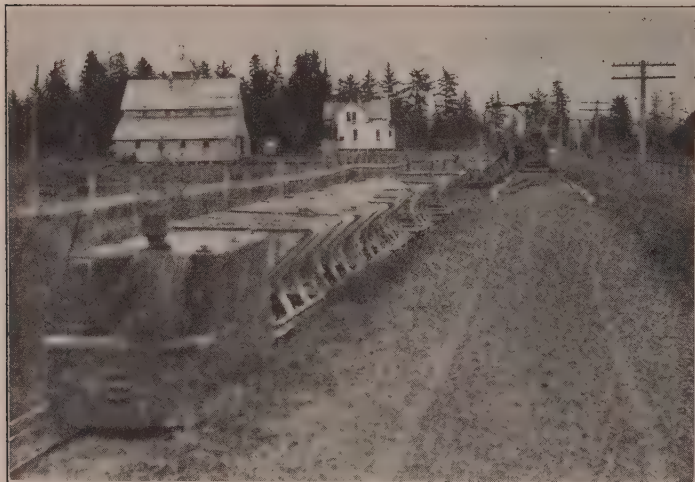
SECTIONAL TIMBER TRACK FOR SUPPORTING DRAG-LINE EXCAVATOR IN TRANSIT

concrete. It is self-propelling and is operated by a 14-hp gasoline engine. The new feature of the machine is the special charging arrangement, shown in one of the accompanying views. This consists of a 10-ft. crane with a traveling carriage from which is suspended a special bail. When a train reaches the point of work this crane picks up the car bodies one at a time and dumps them into the charging hopper of the mixer. A 2-in. pipe line laid along the roadway and served by a gasoline pumping engine supplies water for the mixer and for sprinkling the finished pavement.

With the maximum haul required on this road work, which was 2 mi. from the central loading plant, one locomotive was just able to keep the mixer in continuous operation. This mixer with a crew of eight men averaged 400 lin. ft. of pavement 8 ft. wide

the machine, to make a track about 100 ft. in length. The chief feature of these sections is the staggered arrangement of the top timbers, which the sketch shows. When the machine is traveling in the direction of the arrow, this arrangement gives the rollers a bearing on the section of track ahead before they leave the section behind, and prevents the rollers from striking a projecting joint. This construction also makes it possible to take quite sharp curves while still maintaining a solid bearing over the joints. For traveling over very soft ground the bottom flooring may be extended to the ends of the ties, thus giving more bearing surface.

In moving, the sections are picked up by a four-way chain attached to the four U-bolts shown in the drawing. The four chains meet in a common ring which also



GASOLINE-DRAWN INDUSTRIAL TRAINS AND CONCRETE MIXER TO WHICH THEY CARRY MATERIAL

and stone are handled by means of a grab-bucket. An industrial track with switches at each end is laid from the bins to the point where the mixer is working. This track is made of 16-lb. rails and comes in 15-ft. portable sections with seven steel ties to the section. On it are operated three trains made up of six cars each, each car having cradles for three 9-cu. ft. Koppel dump car bodies. While one train is being loaded at the bin and one emptied at the mixer, the third is in transit, drawn by one type M20 four-cylinder Milwaukee gasoline locomotive. The main bins empty into measuring hoppers, which in turn discharge into the car bodies. In one instance cars at the loading plant were handled by a winch-head line; otherwise cars at both ends of the line were moved by hand.

An Austin cube mixer with 20-ft. boom and turnover discharge bucket of 1/3 cu. yd. capacity is used to mix and place the

and 6 in. thick per day, while the record run for an 8-hr. day was 552 ft. On 16-ft. wide pavement the average progress has been 270 lin. ft. per day, with a maximum of 383 ft. in eight hours. This method of handling materials was developed by Henry Bowlby, State highway engineer of Oregon.

Plank Track Carries Drag-Line Excavator Half Mile in 10 Hours

TIMBER track built in 20-ft. sections facilitated the movement of a Bucyrus drag-line excavator on the Mt. Olive levee work on the Lower Mississippi. This device was described in a recent number of the "Excavating Engineer" by J. M. Whitely of Cape Girardeau, Mo.

Ten of these sections, the construction of which is shown in the accompanying sketch, are used, five under each side of

holds a short chain with a large hook. For ordinary service two cable clamps are put on the drag-line cable 3 in. apart, and about 10 ft. from the end. The large hook is hooked between these. One pair of bridle chains is made a few inches shorter than the other pair, so that each section swings higher at the end farthest from the machine as it is being sent ahead. This allows the joint to be easily matched and the section to be quickly lined as it is being lowered into place. All sections must be placed in the runway just as they came out. As ordinarily the act of swinging them from the rear to the front of the machine would change them end for end, in hooking on, the chains should be given a half twist so that the section will turn itself in transit.

Mr. Whitney says that these sections may be swung ahead and placed in a minute and a half. By using them he was able to move his machine 2600 ft. in 10 hr.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Eighty-two Men Dismissed from N. Y. Barge Canal

State Engineer's Retrenchments Will Save \$83,000 a Year in the Middle Division Alone

The policy of retrenchment being carried out by Frank M. Williams, State engineer of New York, at the request of the Governor has resulted in the dismissal from the middle division of the State Barge Canal of eighty-two engineering employees. The terminal engineer offices have been, or will be abolished, and the work formerly carried on under their direction is to put in charge of the division engineers. It is expected that \$250,000,000 a year will be saved in the engineering supervision of the canal. The dismissals were made, according to law, in inverse order of the dates of appointment. When construction is resumed in the spring, some of these men will be taken back. The men whose services have been dispensed with range from the rank of laborer to that of terminal engineer.

American Society Members Inspect New York's Engineering Works

As part of the program of its annual meeting in New York last week the members of the American Society of Civil Engineers, on Jan. 20, through the courtesy of the Public Service Commission for the First District and of the contractors, visited the section of the Lexington Avenue subway between Ninety-sixth Street and One Hundred and Twenty-fifth Street. This section, in which the structural part of the contract is practically complete, is complicated by the necessity of separating express and local traffic into an east and west branch, as is done at Ninety-sixth Street on the present subway, but without the use of crossovers. The trip covered sections 12 and 13 or route 5. Guides were provided from the engineering force of the commission, and the engineers were taken through in small parties as they arrived. Every little way water color cross-sections suspended from the tunnel roof and lighted with electric lamps made clear the track separation construction.

Organization of Street Cleaning Officials Is Planned

Plans are being considered for the formation of an organization of street cleaning officials of the United States and Canada. During the recent exhibition of apparatus held under the auspices of the New York Department of Street Cleaning, an informal conference considered the question and the following committee was appointed to examine into the desirability of creating a new street cleaning organization. The members of this committee are J. T. Fetherston of New York, chairman; Richard T. Fox, of Chicago; Gus Hanna, of Cleveland; Walter G. Leininger, of Chicago, and G. B. Wilson, of Toronto. This committee has sent out a circular letter to street cleaning officials throughout the United States and Canada asking their opinions as to the need of such an organization as is proposed.

Progress of Boston Port Directors

It is quite well understood that the Port Directors, Boston, will shortly be ready to submit to the Governor and Council their conclusions as to the construction of the proposed drydock.

Another Medal for Colonel Goethals

In recognition of his work at Panama the Geographic Society of Chicago, at its annual dinner Jan. 23, presented a gold medal to Col. Goethals.

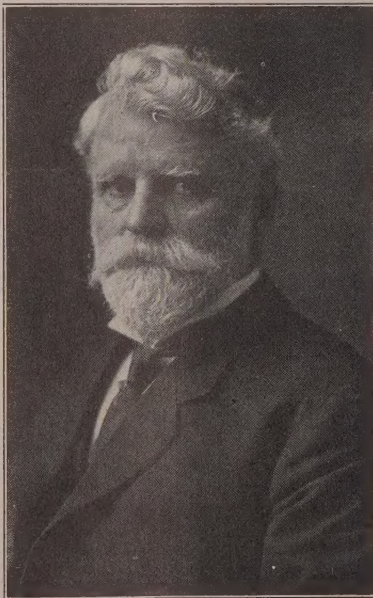
Bills to Control Road Building and Practice of Architecture

Among the bills introduced recently in the assembly of New York State are the following:—

To appropriate \$10,000,000 for the construction of New York State highways.

To amend the general business laws in relation to the practice of architecture. This bill

ENGINEER WHO HAS GIVEN INITIAL FUND FOR ENGINEERING FOUNDATION



AMBROSE SWASEY

provides for the registration of all architects in New York State. There is to be a board of examiners composed of five architects who have been in active practice in New York State for not less than ten years. The board of examiners, in lieu of all examinations, may accept satisfactory evidence of the qualifications of candidates. All persons applying for examination or certificate of registration are required to pay a fee of \$25. Violations of the proposed law are to be considered misdemeanors punishable by fines for the first offense, and fines and imprisonment for subsequent offenses.

To amend the highway law generally: This bill would create a commission of three members to be appointed by the Governor instead of the existing single-headed commission. One of them is required to be a "practical civil engineer with actual experience in the construction of highways and bridges." The commission is to appoint two deputies, each of whom shall have had practical experience at road building. To the end that employees of the Department of Highways engaged in the work of constructing roads may be practical highway builders the commission is authorized to indicate to the Civil Service Commission the relative value which should be given to experience and scientific attainments.

Engineering Foundation Started with \$200,000 Gift

Ambrose Swasey Gives Initial Endowment to Be Devoted to the Advancement of Engineering

Accompanied by the announcement of a gift of \$200,000 by Ambrose Swasey, of Cleveland, the Engineering Foundation was formally inaugurated in the United Engineering Societies' Auditorium in New York Jan. 27. The chief thought uppermost in the minds of the speakers was that Mr. Swasey's gift would form an example for other successful engineers and that other contributions to the endowment would be rapidly forthcoming. The obligation of the profession and of mankind to Mr. Swasey for taking the initiative in starting the foundation found appropriate expression. Two of the speakers, Gano Dunn, past president of the American Institute of Electrical Engineers, who presided, and Capt. Robert W. Hunt, referred to the establishment of the foundation as a means, incidentally, for breaking down the barriers that seem to have existed between the American Society of Civil Engineers and the other three national engineering societies, since the former elected not to join forces with the latter in the Thirty-ninth Street Building.

As to the purpose of the foundation, nothing additional to what had already been given out was announced. The funds are to be "devoted to the advancement of the engineering arts and sciences in all their branches, to the greatest good of the engineering profession and to the benefit of mankind." Presumably much or all of the income will be used in research work, which, appropriately, formed the text for an address by Dr. Henry S. Pritchett, president of the Foundation for the Advancement of Teaching.

The management of the fund will be in the hands of the Engineering Foundation Board, two representatives each from the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers, two members at large (chosen from men outside the profession) and, finally, the president of the United Engineering Society. The members of the board of the three national societies other than the American Society of Civil Engineers are to be elected by the trustees of the United Engineering Society.

The formal acceptance of the gift was left to Dr. Alexander C. Humphreys, who, in a graceful address, received it on behalf of the foundation board. Charles Macdonald, past president of the American Society of Civil Engineers, gave hearty assurance of the co-operation of that society in the work of the foundation. All of the speakers bore tribute to the high character of the initial donor to the fund and to his noble devotion to the interests of his fellowmen.

AMBROSE SWASEY

Mr. Swasey, as is generally known to engineers, is president of the Warner & Swasey Company, of Cleveland, prominent machine tool manufacturers and the foremost builders of telescopes in the world. Among the instruments which they have designed are the famous Lick, Yerkes, and the United States Naval Observatory telescopes, as well as the great 72-inch reflecting telescope for the Canadian Government, which is now under construction. Mr. Swasey is known, in addition to his engineering achievements, for his practical efforts towards scientific education and the advancement of the profession. His gift for the establishment of the Engineering

Foundation is in line with these undertakings. As president of the Warner & Swasey Company, he has interested himself in the establishment and conduct of its school of apprentices in an endeavor to aid men to help themselves.

Mr. Swasey was born in Exeter, N. H. At the age of eighteen he entered upon the machinist's trade in Exeter, and in 1870, in company with his present partner, Worcester R. Warner, engaged with the Pratt & Whitney Company, at Hartford, Conn. In 1880, he resigned his position with the Pratt & Whitney Company and, together with his present partner, established in Cleveland a business which has since grown to large proportions.

Although the making of astronomical instruments was not in their original scheme, Mr. Warner's taste for astronomy, and his interest in the appliances used by astronomers, combined with Mr. Swasey's love for artistic design, and his ability as a mechanical engineer, very naturally led them to take hold of the questions pertaining to such instruments. In 1886 the trustees of the Lick Observatory invited four firms to submit designs for the 36-in. telescope, which was to be the largest and most powerful ever constructed. Two of the competing firms were from abroad and two from the United States. After careful consideration the plans submitted by Messrs. Warner & Swasey were accepted, and they were awarded the contract, although their price was the highest.

This instrument was subjected to much criticism, but it stood all the tests and when the Government desired to reconstruct the Naval Observatory at Washington in 1890, the Warner & Swasey Company were given the contract for the 26-inch telescope; and they were also later entrusted with the task of making the 40-in. telescope, and also the 90-ft. dome and the 75-ft. elevating floor for the Yerkes Observatory, at Williams Bay, Wis.

The manufacture of meridian circles, transits and other astronomical instruments of extreme accuracy and precision has formed a large part of the firm's work, and in the designing of all these instruments Mr. Swasey has taken an important part. For graduating the fine circles of these delicate instruments it was necessary to have a circular dividing engine, and as there was no instrument in the country of sufficient accuracy, the problem was taken up of designing and perfecting such an engine which, when completed, was capable of dividing circles automatically up to 40 in. in diameter with an error less than one second of arc.

Mr. Swasey is the inventor of a number of instruments used by the Government in its coast defense, including several improvements in the construction of range finders.

Many honors have come to Mr. Swasey. He is a past president of the American Society of Mechanical Engineers, a member of the Institution of Mechanical Engineers of Great Britain and of the British Astronomical Society, a fellow of the Royal Astronomical Society, past president of the Cleveland Engineering Society, and, in 1900, received from the French Government the Legion of Honor for his achievements in the designs and construction of astronomical instruments.

World's Largest Low-Head Turbines in Operation

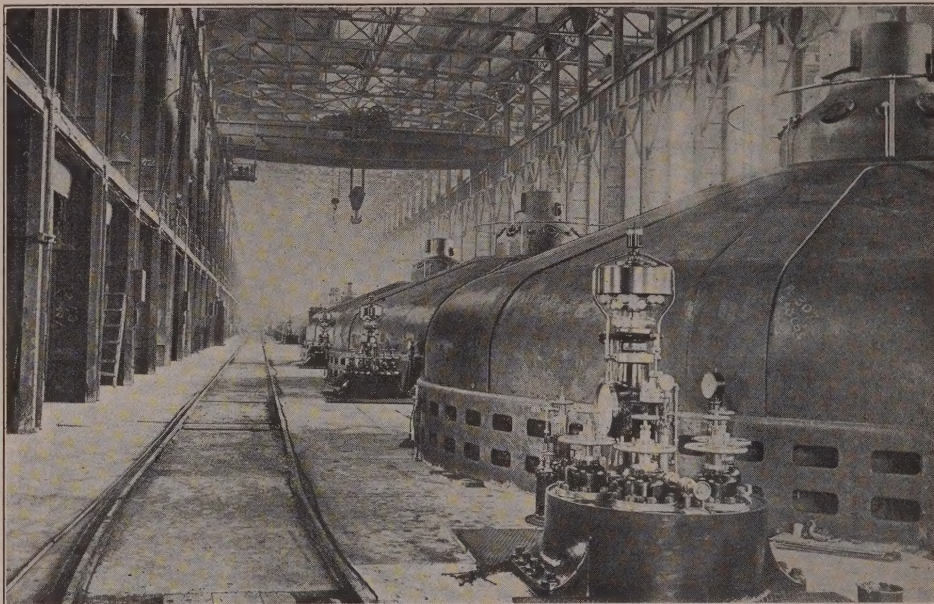
Cedars Rapids Development without Dam, Has Ten 10,800-Horse Power Main Units and Two-Mile Headrace

The Cedars Rapids Manufacturing & Power Company's plant at Cedars, P. Q., was put in operation Jan. 1. It is one of the largest low-head developments in operation, having not less than ten 10,800-hp main units and three 1500-hp excitors. Ultimately there will be eighteen main units and six excitors. The plant has no dam; 56,000 sec.-ft. of water are

Court Rules on Validity of Foundation Patent

Decides Suit of O'Rourke Engineering Construction Company Against the Foundation Company, Involving Watertight Cellar Construction

Judge Hand, in the U. S. District Court, has handed down a decision in the case of the O'Rourke Engineering Construction Company versus the Foundation Company. The suit was over the method of making a watertight cellar by sinking a continuous row of caissons around the site, and making the joints between adjoining caissons watertight.



THE TEN 10,800-HORSEPOWER UNITS HAVE THRUST BEARINGS ON TOP OF GENERATORS

diverted directly from the St. Lawrence River through a 2-mi. headrace.

The units are the largest in the world in size, and their capacity is larger than other units built so far to operate under a head of 30 ft. To economize on concrete in the substructure and to lessen the vibration in the units, the thrust bearings have been placed on top of the generators, as shown in one of the accompanying photographs. It is stated that even at run-away speed the vibrations are hardly noticeable. The design was described in detail in the Engineering Record of Oct. 25, 1913, page 461, and the construction of the plant was described in the issues of July 18 and 25, 1914, pages 62 and 107, respectively. The contractors for building the powerhouse substructure and the headrace were Fraser, Brace & Company, of New York City; the turbines were built by the I. P. Morris Company and the Wellman-Seaver-Morgan Company; the electrical equipment was delivered by the General Electric Company, the powerhouse superstructure and the transformer house were built by the Unit Construction Company, of St. Louis; and the transmission lines by the Stone & Webster Company.

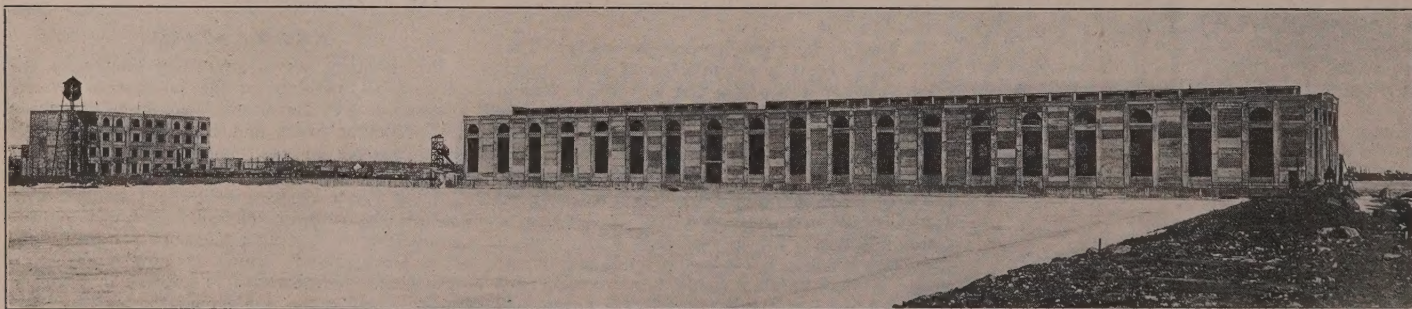
The practical effect of this decision seems to be in dispute. The defendant's point of view is given in the following quotation from a letter received from D. Anthony Usina of counsel for the Foundation Company:

Views of Foundation Company

"The suit was brought under a patent of Mr. O'Rourke's which attempted to monopolize the building of a continuous foundation wall by providing caissons with registering removable sections in their adjacent walls so that after sinking these sections could be removed and the concrete extended continuously from one caisson to the next.

"The suit was brought on three claims, two of which covered this idea broadly, and the third of which was limited to securing the caissons together close to the removable wall section, a detail of so little importance that no contest was made on it at the trial.

"The decree of the court was that the broad claims are invalid. The decree reads, 'Claims 1 and 6 thereof are invalid.' The court found that this method of making removable sections in the adjacent ends of the caissons and removing such sections and carrying the con-



THE WORLD'S LARGEST LOW-HEAD TURBINES ARE NOW IN OPERATION AT THE CEDARS RAPIDS PLANT IN CANADA

crete through continuously had been practised in the foundations for the Commercial Cable Building about four years prior to the application for the O'Rourke patent, so that the general plan was not new.

"The court held that the detail of securing the adjacent walls together close to the removable sections was the only improvement which Mr. O'Rourke had made, and held his patent valid and infringed as to this detail.

"The effect of the suit is to throw open to the public the right to join its caissons in this way by any method which does not involve the securing of the adjacent walls of the caissons together close to the removable section, or any equivalent scheme."

Mr. O'Rourke's Reply

The substance of this letter was brought to the attention of Mr. O'Rourke, whose view of the decision is given in his letter, from which we quote:

"As a matter of fact, claim 2 is broader than either claims 1 or 6, and contains the indispensable idea of the patent, namely the connection, and also a joint, unlimited as to area, between the ends of the abutting caissons, which closes the space between them on the side of the opening, thus making one common well extending from the rock to the level of the water, in which the concrete joint is placed and the dam converted into continuous masonry. Claim 1 reads as follows:

"A plurality of caissons having registered openings in adjacent walls of less area than the interior cross-section of the caisson and removable means for closing the openings; substantially as described."

"This means that at the ends of the caissons are wells left in the concrete and closed from the outside with an end wall. These openings are limited to less area than the cross-section of the caissons, but nothing in the claim refers to any connection between the caissons, which" (caissons) "anybody is welcome to build in that way as they are no better with these isolated and enclosed openings than if filled solid as long as the connection covered by claim 2 is not used. Claim 2 is:

"A plurality of caissons having removable and registering doors or wall sections in adjacent walls, and having their adjacent walls secured together close to said removable doors or wall sections."

"Under the description given in this claim it is possible to remove the registering doors or wall sections after the spaces between the ends of the recesses have been secured together or otherwise connected in accordance with the necessities of the style of caisson used.

"If the joint between the caissons is left open and the end walls are removed, water, quicksand, or any other flowing material, such as always exists where pneumatic caissons are used, would flow into the joint and prevent either its excavation or subsequent filling with concrete, so that the common well between the caissons, if not connected, would be like a barrel in the water with two opposite staves missing which could neither be emptied nor filled without the missing staves.

"This joint is not limited by the claim to a less area than the cross-section of the caisson as in claim 1, and may be anything up to its full width. Claim 2 is therefore broader than claim 1 since it covers a series of unit caissons and the way of connecting them into a monolithic dam. Under the ruling of the court, the method of closing the opening on each side of the well between the caissons, however simple or slight, even as the court puts it—"should tar-paper be used"—would be an infringement, and 'would allow a newcomer to get all the good of the invention.'

"The Foundation Company's counsel states that 'the effect of the suit is to throw open to the public the right to join its caissons in this way by any method which does not involve the securing of the adjacent walls of the caissons together close to the removable section, or any equivalent scheme.'.... Claim 2 contains the caisson construction of claim 1 plus the connec-

tion which as the court rules means any connection closing the space between the caissons, so that the public and the Foundation Company have only the right to connect their caissons in some mysterious manner which would not be a connection."

Chicago Engineer Experiments with the Dusting of Concrete Floors

As the result of considerable trouble experienced with the dusting of concrete floors in the new Rand-McNally Building, the Northwest station of the Commonwealth Edison Building, and a number of other Chicago structures, J. L. McConnell, a Chicago civil engineer, made an analysis of the situation, together with a number of experiments which have resulted in his discovering a plastic material called Dustite, said to be waterproof and oilproof.

In making his analysis Mr. McConnell divided the possible remedies into three classes as follows: 1. Placing hardening materials in the concrete. 2. Putting dust preventative over the floor as a paint. 3. Impregnating the pores of the concrete, and also placing a film over the top with a plastic material which would harden with age. In the first case he found the chief factors were workmanship and the difficulty of securing a hardening material that would accomplish the purpose. The painting of the floors gave too thin a covering to stand traffic, and in most cases the paint was found to flake, due to abrasion. Paraffin oil placed on the floors by blow torches gave good results, but the cost was so high as to be prohibitive.

Experiments were then undertaken to dissolve the paraffin in petroleum oil, but it was found that the oil did not carry enough paraffin to be practicable. Finally a plastic material, which held in suspension any grit or dust due to wear, was evolved. The next difficulty encountered was to get it waterproof, as it would wash off in the course of a few weeks, due to mopping. In the end this difficulty was overcome by applying a secondary coat of a fixing material.

The new material was then used on the Northwest station of the Chicago Commonwealth Edison Company, and after two years it is still satisfactory. It is placed on the floor in two coats. For the first coat 1½ lb. of the material are dissolved in 1 gal. of water, applied with a wide wash brush and allowed to dry for four hours. Then ½ lb. of the fixer is dissolved in a gallon of water and applied. The first coat alone is said to prevent dusting but will not stand washing.

The material comes in 12 to 500-lb. containers and has recently been placed on the market by the Dustite Company, of Chicago.

\$10,000,000 Needed for New York State Road Construction

A request for an appropriation of \$10,000,000 to be used in the construction of State highways in New York is made by Commissioner J. N. Carlisle in his report for the year 1914, which has just been published. No money can be utilized from the second \$50,000,000 bond issue, approved by the voters in 1913, except by a direct legislative act. The department asks that the new appropriation be made available immediately. Fifteen million dollars have already been released, but all of this amount has been obligated or set apart for roads ready for letting. If this money is appropriated early in the session, the commissioner states, contracts for this amount of work can be awarded before spring opens and the roads can be finished during the construction season of 1915.

In order to carry on maintenance work during 1915 Commissioner Carlisle believes that at least \$4,000,000 will be needed. Under the present law motor license fees are required to be used for maintenance of highways, but do not become available until the end of each year. The report recommends a readjustment of motor license fees, taking into consideration horsepower and weight of vehicles.

Wood Preservers Open Ranks to Young Men

At Annual Convention Establish New Class of Membership with Low Dues—Define Eligibility for Corporate Membership

By the creation of a new class of membership with dues of only \$3 the American Wood Preservers' Association, at its eleventh annual convention, held Jan. 19-21 at Chicago, opened its ranks to the younger men of the profession. Along the same broad lines eligibility for corporate membership was voted to include city engineers, professors, railroad, consulting, forestry, county and highway engineers, contracting and inspecting engineers, engineers of tests and city chemists. The collection of data and the getting of them into the hands of the engineer and the architect were considered the next large problems of the association, and to further this end the association will begin the compilation of a manual of recommended practice. The publication of the quarterly "Bulletin" and the "Proceedings" will be continued.

More than 175 members and persons interested in the wood-preserving industry were registered at the convention. Four general subjects formed the basis for as many sessions, at which the fifteen papers and five standing reports were presented. These topics were: Plant operation and miscellaneous subjects; Preservatives and specifications; ties, timbers, piling and cross arms; and wood-block paving. Last year the association adopted the committee form of investigation and reports, and as a result these reports formed the basis of the more valuable discussions.

George E. Rex, president, in his presidential address, called the members' attention to the necessity of good, conservative and unanimous recommendations as to what should be done in the treating business on account of the disturbed conditions due to the war. He recommended the acceptance without question of the American Railway Engineering Association specifications for bridges, buildings and tracks, those of the American Society for Testing Materials for grading lumber, steel, etc., those of the Railway Signal Association for the best practice in railway signaling and his own association's specifications for creosote, zinc chloride and all methods pertaining to treatment.

F. J. Hoxie's paper on "Treated Timber for Factory Construction" brought home to the members the fact that engineers and architects were a long way from knowing much that is considered elementary by timber-treating specialists. Conversely, Mr. Hoxie mentioned problems little appreciated by the members of the preserving industry, such as mill frames and floors where leaching is of little importance and fire hazard within inclosed rooms containing large values demands the most careful consideration.

Preservative Specifications

Dr. Hermann von Schrenk and Alfred Kammerer presented a tentative specification for a coal tar-creosote solution which called forth a protest from A. E. Larkin in which he insisted that the nomenclature be made more specific as to the constituents of the solution. The authors recommended that the mixture be made of the treating plants.

The committee report on preservatives recommending a method of analysis of zinc chloride and a specification for a standard thermometer was adopted.

The report on specifications for the purchase and preservation of treatable timber outlined the fundamentals of the subject, which, with minor changes, were adopted and ordered printed in the manual. The remainder of the report, referring to the purchase of treatable timber and the preparation and specifications for preservation, were received as information.

C. H. Teesdale, chairman of the committee on wood-block paving, presented a paper on "The Bleeding and Swelling of Paving Blocks" which contained much of the same information

given in the Engineering Record of Oct. 17, 1914, page 444. The report of his committee gave a history of treated wood-block pavements in the United States so far as could be obtained by circular letter.

The officers elected for the ensuing year are: President, J. H. Waterman; vice-presidents, H. S. Loud, Lowry Smith, and F. D. Beal; secretary-treasurer, F. J. Angier, of Baltimore. The next meeting will be held in Chicago.

Grand Jury Indicts Merritt & Chapman Company

On charges of having conspired to monopolize the wrecking and lighterage business of New York Harbor and the Atlantic States in violation of the Sherman law, the Federal Grand Jury on Jan. 27 indicted the Merritt & Chapman Derrick & Wrecking Company of New York City.

House Passes \$34,000,000 Rivers and Harbors Bill

Carrying an appropriation of about \$34,000,000 the Rivers and Harbors bill was passed by the House of Representatives last week and is now before the Senate. The House remained in session until 1 a.m. before passing the bill. Few items were stricken from it. Among the appropriations to fail was one for \$150,000 for a survey of the Tennessee River near Florence, Ala., contemplating the removal of Muscle Shoals. This appropriation was believed to be an opening wedge for an \$18,000,000 navigation and water power project.

Charles Edward Guillaume Receives John Scott Medal

Charles Edward Guillaume, of Serves, France, has been awarded the John Scott Legacy Medal and Premium for his alloy invar. The award is made by the city of Philadelphia, acting on the recommendation of the Franklin Institute. The alloy contains approximately 63.8 per cent iron and 36.2 per cent nickel. It is characterized by possessing an extremely small coefficient of linear expansion, about 0.0000004 per degree Centigrade. Within the limits of atmospheric temperature change its expansion is very exactly proportional to the temperature. It has a modulus of elasticity of about two-thirds that of steel, and its hardness is greater than that of hard brass. Dr. Guillaume has done a large amount of research work in connection with iron-nickel alloys, in the course of which he also discovered platinite.

Health Board Must Reconsider Ottawa Water Plans

Further complications have arisen in the Ottawa water supply case, which has been discussed at length in past numbers of this journal. Judge Middleton, on Dec. 28 granted the city a mandamus calling upon the Provincial Board of Health to reconsider Hazen & Whipple's plans for mechanically filtered Ottawa River water, which the board had rejected in favor of the costlier Thirty-one Mile Lake scheme. On Dec. 31, before the court had officially served its order on the board, the latter held a meeting and again condemned the plans for the filtered river supply. The court's formal order was not issued until Jan. 7.

Judge Middleton is specific in his directions to the board. He says: "It is ordered peremptorily that the Board of Health of the Province of Ontario consider, forthwith, the plans and specifications prepared for the said applicant corporation by Messrs. Hazen & Whipple in respect to an improved water supply by way of mechanical filtration of the Ottawa River,

and that in so doing the said board shall not consider the source of supply from which the said water is to be obtained, nor shall they in so doing consider the alleged advantages of any other source of supply, nor shall they in so doing consider the scheme covered by the said plans and specifications in contrast or comparison with any other scheme for supplying water to the city of Ottawa."

Tech. Men to Gather at Pittsburgh for Big Reunion

More than 11,000 graduates of the Massachusetts Institute of Technology have received notices of the "mobilization" of the Technology Clubs Associated at Pittsburgh, Feb. 19 and 20. Morris Knowles, president, and the other members of the general committee have completed plans for the big alumni reunion. The convention headquarters will be at the Hotel Schenley and the program includes numerous class luncheons, excursions, a smoker and a banquet. The speakers at the annual banquet will include President Richard B. Maclaurin of the Institute and probably President A. Lawrence Lowell, of Harvard.

Personal Notes

Jones, Hanscom and Reddick, Inc., and Jesse B. Holly, civil and hydraulic engineers, have removed their offices to the Humboldt Bank Building, San Francisco.

L. R. Lothrop has been appointed by the new Board of Supervisors of San Bernardino County chief engineer of the proposed good roads system to be built under a recent bond issue. Mr. Lothrop was formerly street superintendent at San Bernardino, Cal.

Henry A. Campbell, formerly engineer of the San Francisco Chamber of Commerce, has been appointed consulting engineer of that organization. Mr. Campbell has also opened an office as consulting engineer in the Merchants Exchange Building, San Francisco.

O. H. Basquin and Thomas V. Salt have been awarded the Octave Chanute medals for the best papers presented before the Western Society of Engineers during the past year. Mr. Basquin's paper was on "Columns" and Mr. Salt had as the title for his paper "The Manufacture of By-product Coke."

Lewis W. Baldwin has recently been appointed general superintendent of the Illinois Central Railroad at New Orleans. Mr. Baldwin, who is a graduate of Lehigh University of the class of 1896, entered the service of the Illinois Central as rodman and chairman. He was for a time engineer of maintenance-of-way, and later superintendent of the Kentucky division.

Clarence D. Pollock, formerly in charge of the Bureau of Highways of the Borough of Manhattan, New York City, has been appointed consulting engineer of the Granite Paving Block Manufacturers' Association of the United States, Inc. Mr. Pollock has had over 20 years' experience in charge of paving construction in New York, Brooklyn and Texas. Zenas W. Carter has been selected as field secretary of the association.

E. B. Van de Greyn has opened an office as consulting and constructing engineer in Houston, Texas. He was for a time city engineer and member of the Board of Public Works of the City and County of Denver, Colo. For three years Mr. Van de Greyn was with the firm of Waddell & Hedrick, later Waddell & Harrington, as resident engineer on several important contracts. He has carried on a general engineering business for the past five years in Kansas City and Denver.

Henry V. Macksey, of Boston, has been appointed superintendent of public works at Woburn, Mass. Mr. Macksey, who is a graduate of the Rensselaer Polytechnic Institute, served for ten years in an engineering capacity the Water and Street Department of Boston. He

was also for a time engineer to the directors of the Port of Boston, and has had considerable construction experience in railroad and hydraulic work. He will have absolute control of all municipal department work, and will also be the city's purchasing agent.

Charles J. Crowley, works manager for Jacobs & Davies on their contract on the Fourth Avenue (Brooklyn) subway, has been elected member of the Institution of Civil Engineers, Great Britain. Mr. Crowley was in charge of driving the lower pair of Hudson-Manhattan tunnels, which were constructed by the same firm of consulting engineers. He was also in charge for them of the caisson work on the Hales Bar dam on the Tennessee River. Mr. Crowley comes from England, and has been in this country about fourteen years. He is a member of the Canadian Society of Civil Engineers.

William B. Jackson, of the engineering firm of D. C. & Wm. B. Jackson, Chicago, has been elected president of the Western Society of Engineers. He was born in 1870 at Kennett Square, Pa. In 1890 he was graduated from Pennsylvania State College, and in 1895 received the advanced degree of M. E. Since 1895 Mr. Jackson has been engaged in the design and supervision of the construction of a number of electrical projects, the detailed valuations of electrical properties, the determination of rates for charges of service of electric light, electric railway and telephone properties, and other matters of like character. The breadth of Mr. Jackson's experience is typified by the character of the engineering societies to which he belongs. Mr. Jackson is a member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Gas Institute, the Western Society of Engineers, the National Electric Light Association, the American Street and Interurban Railway Association and several other national and local engineering societies.

Civil Service Examinations

City of Philadelphia.—Examinations to fill engineering vacancies in the Department of Public Works will be held as follows:

ASSISTANT ENGINEER, local residence waived, Feb. 26 and 27, \$2500, Bureau of Highways.

ASSISTANT ENGINEER, local residence waived, Feb. 26 and 27, \$2100, Bureau of Highways.

DRAFTSMAN, Feb. 20 and 27, \$900 to \$1200, Bureau of Surveys.

DRAFTSMAN, Feb. 23 and March 2, \$600 to \$900, Bureau of Highways.

DRAFTSMAN, Feb. 23 and March 2, \$900 to \$1200, Bureau of Highways.

DRAFTSMAN, bridge division, Feb. 24 and March 3, \$1200, Bureau of Surveys.

DRAFTSMAN, Feb. 25 and March 4, \$1000, Bureau of Water.

DRAFTSMAN, Feb. 24 and March 3, \$1000 to \$1200, Department of City Transit.

Except for those examinations where local residence is waived applicants must call in person at the office of the Civil Service Commission, City Hall, Philadelphia, in order to obtain application blanks.

United States.—An examination will be held throughout the country on Feb. 24 and 25 for the position of hull draftsman, at \$1800 a year. Applicants must be over twenty years of age and must have had ten years' experience in ship drafting. A first-class technical education will be accepted as equivalent to not more than five of these ten years. Some experience in dredge design also required. For full information apply to the United States Civil Service Commission, Washington, D. C., or to the secretary of any local United States Civil Service Board.

Examinations Previously Announced

Date	See Eng. Record.
Feb. 6, 1915—Assistant Utilities Engineer, Illinois State....	Jan. 16